Biocultural approaches to sustainability : A systematic review of the scientific literature

Hanspach, Jan

2020-09

Hanspach , J , Haider , L J , Oteros-Rozas , E , Olafsson , A S , Gulsrud , N M , Raymond , C M , Torralba , M , Martin-Lopez , B , Bieling , C , Garcia-Martin , M , Albert , C , Beery , T H , Fagerholm , N , Diaz-Reviriego , I , Drews-Shambroom , A & Plieninger , T 2020 , ' Biocultural approaches to sustainability : A systematic review of the scientific literature ' , People and Nature , vol. 2 , no. 3 , pp. 643-659 . https://doi.org/10.1002/pan3.10120

http://hdl.handle.net/10138/330552
https://doi.org/10.1002/pan3.10120

Received: 20 December 2019 | Accepted: 18 May 2020

DOI: 10.1002/pan3.10120

REVIEW AND SYNTHESIS

PEOPLE AND NATURE | BRITISH ECOLOGICAL SOCIETY

Biocultural approaches to sustainability: A systematic review of the scientific literature

Jan Hanspach[1] | Lisbeth Jamila Haider[2] | Elisa Oteros-Rozas[3] | Anton Stahl Olafsson[4] | Natalie M. Gulsrud[4] | Christopher M. Raymond[5,6,7] | Mario Torralba[8] | Berta Martín-López[1] | Claudia Bieling[9] | María García-Martín[10] | Christian Albert[11] | Thomas H. Beery[12] | Nora Fagerholm[13] | Isabel Díaz-Reviriego[1] | Annika Drews-Shambroom[1] | Tobias Plieninger[8,10]

[1]Faculty of Sustainability, Leuphana University Lüneburg, Lüneburg, Germany; [2]Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden; [3]Chair on Agroecology and Food Systems, University of Vic – University of Central Catalunya, Barcelona, Spain; [4]Department of Geosciences and Natural Resource Management, University of Copenhagen, Copenhagen, Denmark; [5]Helsinki Institute of Sustainability Science (HELSUS), University of Helsinki, Helsinki, Finland; [6]Ecosystems and Environment Research Programme, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland; [7]Department of Economics and Resource Management, Faculty of Agriculture and Forestry, University of Helsinki, Helsinki, Finland; [8]Faculty of Organic Agricultural Sciences, University of Kassel, Kassel, Germany; [9]Institute of Social Sciences in Agriculture, University of Hohenheim, Stuttgart, Germany; [10]Department of Agricultural Economics and Rural Development, University of Göttingen, Göttingen, Germany; [11]Institute of Geography, Ruhr University Bochum, Bochum, Germany; [12]Man and Biosphere Health Research Group, Kristianstad University, Kristianstad, Sweden and [13]Department of Geography and Geology, University of Turku, Turku, Finland

Correspondence
Jan Hanspach
Email: hanspach@leuphana.de

Funding information
Bundesministerium für Bildung und Forschung, Grant/Award Number: 01UU1903; Juan de la Cierva Incorporation Fellowship of the Ministry of Science, Innovation and Universities, Grant/Award Number: IJCI-2017-34334

Handling Editor: Ricardo Rozzi

[Correction added on 22 July 2020, after first publication online: Mario Toralba has been corrected to Mario Torralba.]

Abstract

1. Current sustainability challenges demand approaches that acknowledge a plurality of human–nature interactions and worldviews, for which biocultural approaches are considered appropriate and timely.
2. This systematic review analyses the application of biocultural approaches to sustainability in scientific journal articles published between 1990 and 2018 through a mixed methods approach combining qualitative content analysis and quantitative multivariate methods.
3. The study identifies seven distinct biocultural lenses, that is, different ways of understanding and applying biocultural approaches, which to different degrees consider the key aspects of sustainability science—inter- and transdisciplinarity, social justice and normativity.
4. The review suggests that biocultural approaches in sustainability science need to move from describing how nature and culture are co-produced to co-producing knowledge for sustainability solutions, and in so doing, better account for questions of power, gender and transformations, which has been largely neglected thus far.

KEYWORDS

bio-cultural, conservation, knowledge, social–ecological systems, Sustainable Development Goals, transformation, values

1 | INTRODUCTION

Biocultural approaches to sustainability are gaining attention in academia as ways of simultaneously representing, interpreting and shaping human and cultural dimensions of complex social–ecological systems (Merçon et al., 2019) . Although the concept originates from the field of biological anthropology, where it has mainly been used to describe the effects of social environments on human health and biology, the actual application is much broader and elusive (Wiley & Cullin, 2016). From anthropology, the concept has been spreading to other fields and the definition of the concept has shifted away from human biology towards an emphasis on the tight interlinkages between human societies, particularly their cultural sphere, and the natural and biophysical environment in which they exist. Most prominently, this development gave rise to the idea of biocultural diversity that has been defined as the 'diversity of life in all its manifestations—biological, cultural and linguistic—which are interrelated within a complex socio-ecological adaptive system' (Maffi, 2005, p. 602). The term biocultural diversity has partly been confined to the realm of indigenous and local people's worldviews and livelihood strategies and their effects on biodiversity. However, it has also been argued that more attention should be given to the cultural values and practices of communities and human populations in transformed rural areas and urban landscapes (Buizer, Elands, & Vierikko, 2016; Cocks, 2006).

Diverse ontological, epistemological and ethico-political dimensions of biocultural approaches have also been stressed by different sectors of academia, practice and global environmental policy-making (Merçon et al., 2019). Most importantly, biocultural approaches have gained ground recently, because they are seen as well suited to address sustainability challenges. Thereby they are part of a broader shift from a unidirectional utilitarian conceptualization of nature and narrow disciplinary solutions, towards more systemic and inclusive approaches that acknowledge a plurality of worldviews and human–nature interactions (Maffi & Woodley, 2010; Merçon et al., 2019; Pungetti, 2013). These features potentially also include participatory, transdisciplinary approaches that take into account multiple evidences in knowledge production processes and governance for sustainability (Raymond, Kenter, Kendal, van Riper, & Rawluk, 2019), and are inclusive of different ways of knowing, especially through incorporating lay and non-scientific knowledge from diverse actors, thus enabling a genuine co-production of knowledge (Tengö, Brondizio, Elmqvist, Malmer, & Spierenburg, 2014).

The need to respect and take into account diverse forms of knowledge and worldviews was expressed prominently towards the broader public as early as 1988 through the Declaration of Belém (Declaration of Belém, 1988) and the following decades brought an increasing uptake of biocultural approaches in global sustainability policies. The Convention on Biological Diversity (CBD, 1992), for example, required that the knowledge, practices and innovations of indigenous and local communities that are relevant for the sustainable use of biological resources should be respected, preserved and maintained. More recently in 2010, UNESCO and the CBD launched a joint programme on biological and cultural diversity (www.cbd.int/lbcd/), which led to further recognition of biocultural diversity (e.g. through the Florence Declaration produced in 2014). Increasingly, it has been demanded for science-policy forums to become more inclusive and incorporate different perspectives and worldviews, as illustrated by the efforts of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES; Díaz-Reviriego, Turnhout, & Beck, 2019; Turnhout, Bloomfield, Hulme, Vogel, & Wynne, 2012), as well as processes for navigating diversity and conflict among them (Kenter et al., 2019). The IPBES global assessment highlights the role of indigenous and local communities in managing and preserving biodiversity and ecosystem services (IPBES, 2019) and the IPBES assessment on pollinators and pollination illustrates how biocultural approaches can guide governance and practice in this endeavour (Hill et al., 2019). Precisely by its ability to bridge diverse knowledge systems and policy, biocultural approaches could become powerful tools in the pursuit for sustainability (Merçon et al., 2019; Sterling et al., 2017). However, biocultural approaches are typically referred to in a broad and vague way, and it yet needs to be explored how they are applied and how they actually can unfold their potential for finding much needed sustainability solutions.

For this review, we focus on the contributions of and potential for biocultural approaches in advancing sustainability science (Kates et al., 2001). Very broadly, we interpret sustainability science to include all research that is concerned with sustainability issues (not necessarily assuming that the authors of the research articles analysed would self-identify as sustainability scientists). We assessed how the literature engages with the main principles of sustainability science, the inclusion of different knowledge types through inter- and transdisciplinarity and the attention to social justice issues and the consideration of normative goals as represented by the Sustainable Development Goals (SDGs; UNGA, 2015).

Our assessment complements recent reviews of biocultural approaches that have focused on the theoretical perspectives underpinning these approaches and the different biocultural discourses (Bridgewater & Rotherham, 2019; Cocks, 2006; Merçon et al., 2019). Our aim is to systematically delineate contrasting conceptions and applications of biocultural approaches in sustainability research to gain a clear and thorough understanding of the diversity of perspectives on biocultural approaches available in the scientific literature. This understanding will allow for a greater appreciation for the richness and complementarity of the different biocultural approaches, promote interdisciplinary debates around these approaches and help to unfold their full potential in future applications in sustainability science.

2 | METHODOLOGY

We queried the Scopus database with the search strings 'biocultural' or 'bio-cultural' in Title, Keywords, Abstract for publications between 1990 and 2018. The query returned 1,359 publications. Other

databases than Scopus were not considered as we were interested in gathering the scholarly literature on the topic that has been published in international journals, acknowledging the limitations of this approach. In a first round of screening, we included only publications related to sustainability and environmental issues, as well as natural resource management, and excluded papers that were purely focusing on topics from palaeontology, theology, psychiatry, human evolutionary biology and biological anthropology. The first screening was split between two authors (J.H., L.J.H.) after an initial joint screening to calibrate the assessment. Screening was cross-checked by a third person (T.P.) on a random subset and on publications where the first screening did not lead to a clear classification (suitable or not). We also excluded non-English articles and all books and book chapters. Thus, the first round of screening yielded a total of 431 scientific articles written in English. Subsequently, we did a second round of screening based on the full text, where we classified publications according to the depth of engagement with biocultural approaches. For this, we classified all publications into either only mentioning the term as a buzzword or only very generally making a connection without actually engaging with the concept, and into papers that engaged in depth with biocultural approaches, dedicating substantial parts of the paper to it (see Figure 1). This second round of screening yielded a set of 178 papers with a primary focus on biocultural approaches, which we included in the review (see Figure S1 in the Supporting Information for a detailed description of the selection criteria in a flow chart. A list of the reviewed papers is available in the Data Sources section).

The review process was a combination of deductive and inductive and quantitative and qualitative approaches in order to gain a rich understanding of the available literature. Deductive coding was done for 12 different predefined categories, which are summarized in Table 1. For each of the categories we calculated descriptive statistics.

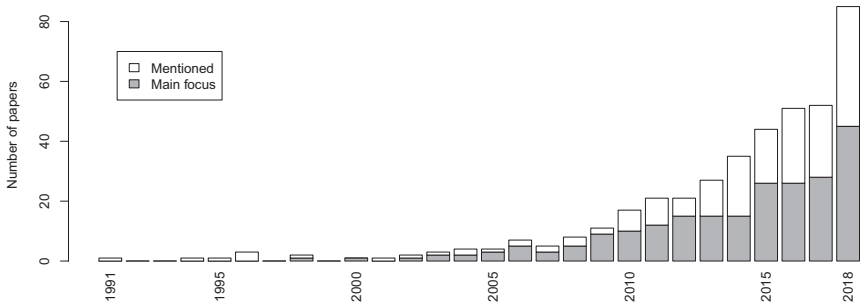

FIGURE 1 Number of publications that either only shortly mention 'biocultural' or have it as the main focus. Only papers with the main focus on biocultural approaches were included in this review

TABLE 1 Categories used for deductive coding of the articles

Name	Description	Data type
Type of paper	What type of paper is it?	Categorical (conceptual, discussion, empirical, review)
Emphasis	Does the study mainly focus on cultural (or social) aspects or on biological (or ecological) aspects?	Ordinal (1—purely cultural; 2—mainly cultural; 3—balanced; 4—mainly biological; 5—purely biological)
Focus	Does the study emphasize preservation/conservation or dynamic/transformation of biocultural components?	Ordinal (1—conservation; 2—balanced/mixed; 3—transformation)
Knowledge type	Focus on which type of knowledge	Ordinal (1—local/traditional; 2—mixed; 3—scientific)
Value type	Which type of value (Chan et al., 2016) does the paper focus on?	Categorical (instrumental, relational, intrinsic)
Power	Does the study consider power? If yes, how?	Dummy (yes/no)
Gender	Does the study consider gender? If yes, how?	Dummy (yes/no)
Action	To which degree is the paper a call for (participatory) action?	Ordinal (0—not mentioned; 1—mentioned but not the main focus; 2—action is the main focus)
Governance	Which types of governance and decision-making is emphasized?	Categorical (not considered, bottom-up/decentralized, polycentric/multilevel, top-down/centralized)
Sustainable Development Goal (SDG)	To which main Sustainable Development Goal does the paper refer to?	Categorical (0 = no reference; goals 1–17)
Transdisciplinarity	To what extent are non-scientific actors involved in the research process (Brandt et al., 2013)?	Ordinal (0—no involvement of non-scientific actors; 1—informed by/consultation of non-scientific actors; 2—collaboration with/empowerment of non-scientific actors
Scientific discipline	Which discipline does the study most strongly connect to? (based on author affiliation or journal; following the classification of the German Research Foundation DFG with the addition of Sustainability Science	Categorical (agriculture, forestry and veterinary medicine; biology; construction engineering and architecture; geosciences; humanities; social and behavioural sciences; sustainability science)

Coding was equally split between multiple authors and inconsistencies or questions were discussed. Inductive coding was performed in two rounds. We split the first round of coding between multiple authors (A.S.O., N.M.G., C.M.R.) assessing how 'biocultural' was defined and what motivated the concept's application in a given paper. Facilitated through a series of deliberative discussions within a workshop setting, this led to the establishment of nine different codes. In a second round of coding, done by a single person (J.H.), these nine codes were refined to a final set of seven codes, which were then discussed with all authors involved in the first round of inductive coding. Subsequently, we called these inductive codes 'biocultural lenses', or in other words, different ways of understanding and applying biocultural approaches to sustainability. Hence, we use the term 'biocultural lens' as a shared epistemological approach. Recognizing that papers rarely can be assigned to a single lens and aspects from different lenses can co-occur within a single paper, we distinguished between primary lenses, that is, the main affiliation of a paper to a lens, and secondary lenses, that is, other lenses that a paper could be assigned to.

In addition to presenting the identified lenses, we quantitatively analysed the lens assignment using a multivariate analysis. Specifically, we applied a detrended correspondence analysis (DCA) of the coded lenses based on a matrix with a value of 1 for a primary lens and 0.5 for secondary lenses. In order to understand how the resulting pattern relates to other characteristics of the papers, we used a post hoc test to assess the correlation of the ordination space with variables from the deductive coding (Permutation test with 9,999 permutations and a significance level of 0.05).

3 | RESULTS

3.1 | General overview

We reviewed a total of 178 papers that had a primary focus on biocultural approaches (Figure 1), most of which were empirical studies (*N* = 104; Figure 2a). Papers usually considered biological and cultural aspects simultaneously, but there tended to be greater emphasis on the cultural dimension (Figure 2b). Most prominently, papers focused on conservation of biocultural aspects (*N* = 99) and only rarely on transformational change (*N* = 19; Figure 2c). Knowledge types tended to be mixed, but some papers only considered indigenous/traditional (*N* = 59) or scientific knowledge (*N* = 36; Figure 2d). Relational (*N* = 130) and intrinsic values (*N* = 59) were commonly addressed (Figure 2e). The majority of papers did not consider power (*N* = 119; Figure 2f) or gender issues (*N* = 142; Figure 2g). Although recommendations for action were often mentioned (*N* = 80), action was less frequently the main focus (*N* = 43; Figure 2h). In many papers, governance was not considered as a relevant aspect (*N* = 80), while in others polycentric governance (*N* = 54) was mentioned (Figure 2i). Approximately half of the papers (*N* = 84) were not based on a transdiciplinary engagement, one-third of the papers (*N* = 63) shared information or consulted non-academic actors and only 31 papers were deeply engaged through collaboration or empowerment (Figure 2j). Most of the papers were from the fields of biology (*N* = 49), agriculture, forestry, veterinary medicine (*N* = 43) and the humanities (*N* = 34). The main aim of the papers could most often be linked to Sustainable Development Goal 15 ('life on land', *N* = 73; see Figure 3), followed by Goal 11 ('sustainable cities and communities', *N* = 12) and Goal 2 ('zero hunger', *N* = 12).

3.2 | Biocultural lenses

Through primary inductive coding of the definition, motivation and application of biocultural approaches, we identified seven different biocultural lenses. In the following paragraphs we summarize the main characteristics of these lenses.

3.2.1 | Biocultural diversity

This lens (37 papers) uses the concept of biocultural diversity as the central element. It includes papers that conceptualize and define biocultural diversity (Elands et al., 2018; Maffi, 2005), but also papers that redefine it (Cocks, 2006), papers that expand its application, for example, to invasive species (Pfeiffer & Voeks, 2008) or describe additional ways of its description, for example, through arts (Polfus et al., 2017). Furthermore, it includes papers that assess the logic and type of the connection between nature and culture, which is implemented by the idea of biocultural diversity (Frascaroli, 2016; Grant, 2012). This lens also contains studies that develop indicators of biocultural diversity (Loh & Harmon, 2005; Winter, Lincoln, & Berkes, 2018) or describe specific components of biocultural diversity (Polfus et al., 2016; Stepp et al., 2004). Also, the *biocultural diversity* lens includes papers that describe the rationale for why biocultural diversity can be important for sustainable development (Sadowski, 2017).

3.2.2 | Biocultural conservation

The *biocultural conservation* lens (24 papers) emphasizes some kind of conservation and its implementation and improvement. Papers within this lens range from improving biodiversity conservation with biocultural methods (Caillon, Cullman, Verschuuren, & Sterling, 2017), to the need to simultaneously achieve biological and cultural conservation (Dunn, 2008; Ens, Scott, Rangers, Moritz, & Pirzl, 2016) to genuinely conserve biocultural diversity (Hill, Cullen-Unsworth, Talbot, & McIntyre-Tamwoy, 2011; Rozzi, 2012a; Rozzi, Massardo, Anderson, Heidinger, & Silander, 2006). The role of indigenous peoples in the co-management of conservation areas is an example of how empowerment of local communities and conservation of cultural aspects can contribute to successful biodiversity conservation (Stephenson, Berkes, Turner, & Dick, 2014). Notably, some of the other lenses (e.g. *biocultural diversity*, *biocultural history and heritage*, *biocultural knowledge and memory*) also make connections to conservation, but only here it is the main focus and therefore also tends to be more strongly action-oriented than the others.

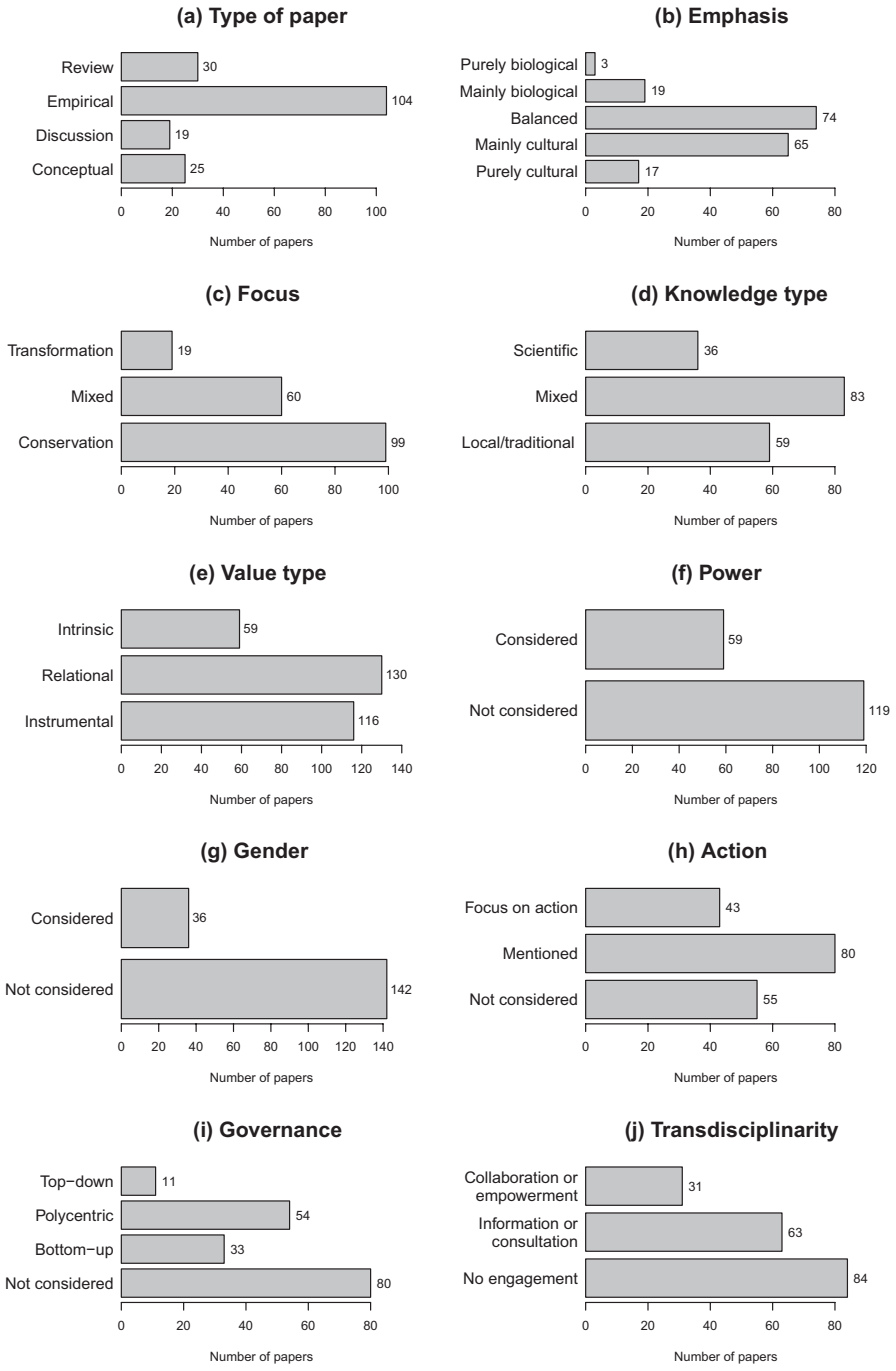

FIGURE 2 Descriptive overview of the characteristics derived through deductive coding. This includes (a) type of paper, (b) main emphasis, (c) focus, (d) knowledge type, (e) value type, (f) consideration of power, (g) consideration of gender, (h) consideration of action, (i) governance type and (j) degree of transdisciplinarity

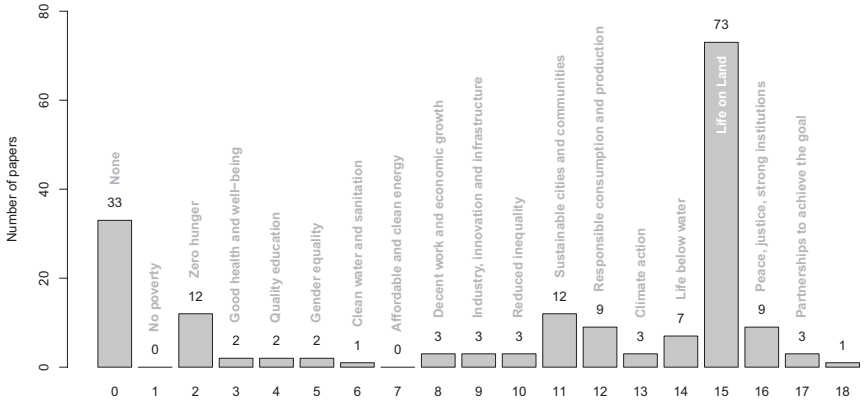

FIGURE 3 Frequency distribution of the main Sustainable Development Goal (SDG) considered by the reviewed papers. If a given paper could not be linked to a specific goal it was counted as zero. One of the papers argued for the need for an SDG 18, which would entail cultural sovereignty and its interconnectedness with biodiversity

3.2.3 | Biocultural landscapes and natural resources management

This lens (35 papers) emphasizes a spatial view and uses the concept of (cultural) landscapes (or seascapes) as a spatial and tangible expression of a long history of human–environment interaction and co-evolution of cultural and biological characteristics, such as biocultural refugia (Barthel, Crumley, & Svedin, 2013). Therefore, such cultural landscapes are often seen as inherently rich in diversity (Bridgewater, 2002) and the need to continue traditional (land) uses such as farming is frequently stressed. In general, there is often a strong connection made to the use (Laird, Awung, Lysinge, & Ndive, 2011) and management of natural resources (Agnoletti & Santoro, 2015). While the papers range from a whole landscape approach to focussing on very specific features of such landscapes, for example, trees and hedges (Fukamachi, Miki, Oku, & Miyoshi, 2011), space is usually taken as the analytical entry point (Ciftcioglu, Uzun, & Nemutlu, 2016), or as an arena of interaction between humans and the environment (Bridgewater, 2002).

3.2.4 | Biocultural history and heritage

The *biocultural history and heritage* lens (18 papers) focuses on temporal dimensions including aspects related to long time horizons, time depth, continuity, legacies and tradition. Typical papers describe historical biocultural diversity (Petrucci et al., 2018), study the co-evolution of biological and cultural diversity (Cevasco, Moreno, & Hearn, 2015; Lezama-Núñez, Santos-Fita, & Vallejo, 2018), describe historical land uses, question the idea of pristine nature, for example, in the Amazon forest (Heckenberger, Russell, Toney, & Schmidt, 2007) and stress that a long history is something valuable that needs to be maintained (Rotherham, 2015).

3.2.5 | Biocultural knowledge and memory

The *biocultural knowledge and memory* lens (38 papers) focuses on knowledge, practices, beliefs and values as expressions of biocultural diversity and a long history of human–environment interaction. Papers in this lens sometimes very specifically focus on individual species (Singh, Srivastava, Padung, Rallen, & Taki, 2012), specific purposes (González, Carvalho, Vallejo, & Amich, 2017), single land use types (Neulinger, Vogl, & Alayón-Gamboa, 2013), certain spatial units, such as watersheds (Iniesta-Arandia et al., 2015) or islands (Kueffer & Kinney, 2017) or how knowledge and memories can be maintained (Aston Philander, Makunga, & Platten, 2011). Usually, papers talk about indigenous or traditional forms of knowledge and memories, and sometimes these are described as gender specific (Cocks, Bangay, Wiersum, & Dold, 2006). The lens also includes papers that relate knowledge to empowerment and participation (Robertson & Hull, 2003) to improve conservation measures and management (Ens et al., 2015; O'Neill, Badola, Dhyani, & Rana, 2017).

3.2.6 | Biocultural ethics, rights and sovereignty

This lens (six papers) puts the main emphasis on issues around justice, rights and sovereignty of local or indigenous people. It tends to be action oriented from a justice perspective. The *biocultural ethics, rights and sovereignty* lens includes papers that very broadly relate to biocultural ethics (Eser, 2009; Rozzi, 2012b) or that are more specific, such as on the matter of legal recognition of traditional knowledge and their holders in international treaties (Srinivas, 2012), as well as on the matter of patenting specific geographical indications (Samaddar & Samaddar, 2010).

3.2.7 | Biocultural restoration, transformation and design

This lens (20 papers) focuses on guiding and implementing change towards desirable futures. It includes papers on biocultural restoration, which also have a strong connection to the conservation lens. Typical papers highlight that the restoration of ecosystems should jointly happen with cultural revitalization (Kurashima, Jeremiah, & Ticktin, 2017), that it should be guided by local knowledge and values (Lyver et al., 2015, 2016) and co-designed, implemented and monitored with indigenous people (Kuzivanova & Davidson-Hunt, 2017; Morishige et al., 2018). The lens also includes papers that engage with different ideas of societal transformation. Almada and Coehlo (2015), for example, critique the Western paradigm of development and others advocate for the idea of endogenous development, that is, a development from within a system (Apgar, Ataria, & Allen, 2011; Davidson-Hunt et al., 2012). Some papers show how gastronomic heritage can serve as a starting point for designing new development pathways (Turner, Davidson-Hunt, & Hudson, 2018). Another paper proposes to use the biocultural diversity concept to transform research and governance in cities (Buizer et al., 2016).

3.3 | Comparing biocultural lenses

The multivariate analysis of the lenses showed that the *biocultural conservation*, *biocultural diversity* and *biocultural history and heritage* lenses were most central to the ordination and had the strongest overlap with other lenses (Figure 4). This indicates that they are applied in a variety of settings and in different combinations with other lenses. More marginal in the ordination space were the *biocultural restoration, transformation and design* lens, the *biocultural landscape* lens, the *biocultural knowledge and memory* lens and the *biocultural ethics, rights and sovereignty* lens, indicating that their application was more distinct from other lenses. The post hoc correlation showed an increasing consideration of power, action and bottom-up governance in papers from the left-hand side (negative scores in DCA1; Figure 4) to the right-hand side of the diagram (positive scores in DCA1; Figure 4). This means very little consideration of power, action and bottom-up governance in the *landscape* lens and

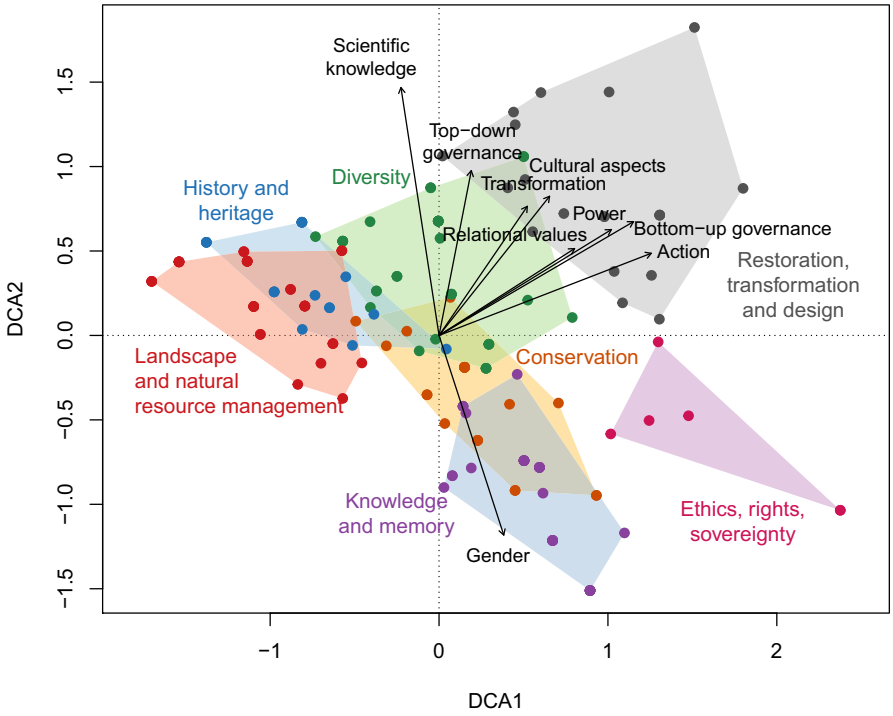

FIGURE 4 Detrended correspondence analysis (DCA) of the primary and secondary lenses of the papers. Dots represent individual papers and polygons enclose all papers belonging to a similar primary lens (coloured labels). Arrows indicate quantitative characteristics of the papers that were significantly related to the ordination space

a strong consideration in the *biocultural ethics, rights and sovereignty* and the *biocultural restoration, transformation and design* lenses. The second ordination axis (DCA2; Figure 4) was related to a gradient from a strong consideration of gender (negative scores in DCA2—papers from the biocultural *knowledge and memory* lens) towards a strong consideration of scientific knowledge and top-down governance (positive scores in DCA2—papers from the *biocultural history and heritage*, the *biocultural diversity* and the *biocultural restoration, transformation and design* lenses). Furthermore, the top-right corner of the ordination, that is, the *biocultural restoration, transformation and design* lens, is characterized by a stronger consideration of cultural aspects and transformation.

In terms of the disciplines engaged there was the strongest association between agriculture, forestry and veterinary medicine and geosciences with the *biocultural landscape* and the *biocultural diversity* lenses (Figure S2). Most distinctly, there was a strong engagement of biology, but also the humanities with the *biocultural knowledge and memory* and the *biocultural conservation* lenses.

4 | DISCUSSION

Through this review we have identified seven different biocultural lenses as ways of how biocultural approaches to sustainability are applied in the scientific literature. Through a combination of qualitative and quantitative methods, we provide a multifaceted characterization of these lenses. In the following paragraphs, we discuss our findings and assess their implications for future research in sustainability science. We base this discussion on how these diverse biocultural approaches to sustainability relate to key components of sustainability science (Kates et al., 2001; Miller et al., 2014) as follows: (a) the adoption of a systems perspective on human–environment interactions, (b) the implementation of inter- and transdisciplinarity and (c) the commitment of providing solutions to sustainability issues.

4.1 | Social–ecological systems perspective in biocultural approaches to sustainability

Sustainability science recognizes the tight coupling between humans and their environment within a complex, adaptive system which requires a holistic approach for studying it (Folke, 2006). Biocultural approaches by definition take such a social–ecological systems perspective (Maffi, 2005). They have been developed to interpret and represent the diversity of worldviews on human–environment interactions to overcome dominant western dichotomous and reductionist's views on nature and culture (Caillon et al., 2017). By acknowledging the inseparable link between nature and culture, the concept has a deeply ingrained systems perspective at its core, thus making it an inherently social–ecological systems view (Liu et al., 2007).

Our findings show the uptake of such a social–ecological systems perspective in different regards. In the reviewed papers, we generally observed a rather balanced consideration of biological and cultural issues and only rarely papers were narrowly limited to specific questions that lacked a systems perspective. Furthermore, the lenses we identified show that biocultural approaches cover a broad range of applications across different contexts. Such applications include applied research ranging from biodiversity conservation and ecosystem restoration to discussions of ethical issues and their implementation in transformational research. These lenses were not exclusive to each other and a considerable overlap

across the different topics and perspectives was evident. Most clearly, this is illustrated by papers that showed strong linkages to multiple lenses and that were difficult to assign to a single primary lens, thus indicating a strong potential of biocultural approaches to bridge topics. For example, Turner et al. (2018) assess how local food products and gastronomic identities of a region can be used to achieve sustainable development trajectories, linking the *heritage* lens with the *restoration, transformation and design* lens. In addition, several papers connected the biocultural diversity lens with other lenses, such as Brosius and Hitchner (2010) to the *conservation* lens, Fukamachi et al. (2011) to the *landscape* lens and Plieninger et al. (2018) to the *restoration, transformation and design* lens.

Furthermore, we commonly found that applications of biocultural approaches study human–environment relationships in particular places with a consideration of interactions across spatial and temporal scales. The majority of the reviewed papers were place-based, empirical case studies. A (spatial) delineation of system boundaries can ease the implementation of a systems perspective. Such a delineation was frequently given through a landscape approach (especially in the *landscape* lens) which closely links to other concepts such as cultural landscapes, that is, landscapes resulting from a long human–environment interaction (Plieninger et al., 2015) and other fields of research, such as landscape ecology (Wu, 2013). Besides spatial patterns and scales, temporal dimensions are key to biocultural approaches and their application. Conceptually, the idea of a potential co-evolution of biological and cultural aspects puts emphasis on the temporal dimensions and dynamics, particularly for biocultural diversity. This is specifically reflected in two of the lenses (*knowledge and memory* and *history and heritage*), as well as in individual, often empirical publications on historical dimensions, legacies and memories (Cevasco et al., 2015).

4.2 | Inter- and transdisciplinarity in biocultural approaches to sustainability

The uptake of a systems perspective in sustainability science, as described in the previous section, requires the consideration of knowledge and methods from different disciplines. In the biocultural lenses, such interdisciplinarity is visible through the broadness of topics that emerge from the cross-disciplinary engagement of scholars. Importantly, many of the represented research communities consider themselves as inherently bridging between disciplines. This includes, for example, the discipline of ethnobiology (Wolverton, 2013) or landscape research (Wu, 2013).

Next to interdisciplinarity, a genuine engagement with non-academic actors, that is, transdisciplinarity, is key to sustainability science (Brandt et al., 2013). Biocultural approaches have arisen from such engagement with non-academic actors and the implementation into policies (Merçon et al., 2019). We suggest that biocultural approaches have served both as a boundary concept, when applied to conceptually or theoretically interpreting human–nature relationships, as well as a boundary object, when applied in practice and action-oriented initiatives. This flexibility of meanings and applications has the potential to be very useful in ongoing and future research in sustainability science. In fact, collaboratively defining boundary objects has been proposed as one important step for achieving transdisciplinarity in practice (Lang et al., 2012). A boundary object is an entity that is shared by several different communities but viewed or used differently by each of them (Star & Griesemer, 1989). That means that a boundary object has an 'interpretive flexibility' which is able to satisfy the needs of users from different social worlds while facilitating communication between them (van Pelt et al., 2015; Star & Griesemer, 1989; Steger et al., 2018), allowing for cooperation and interdisciplinarity without the need for consensus (Baggio, Brown, & Hellebrandt, 2015; Star, 2010). Biocultural approaches in this review have featured interpretative flexibility and divergent understandings and applications across fields and facilitate communication and collaboration across different communities of practice (Steger et al., 2018; Wenger, 1998). However, at the same time this review also indicates very little implementation of the principles of transdisciplinarity in the scientific publications analysed, which can undermine the full potential of biocultural approaches in research for sustainability. Elsewhere it has been shown that biocultural approaches have partly arisen from such transdisciplinary engagement with practitioners and indigenous rights movements in intergovernmental environmental bodies such as the CBD and IPBES (Merçon et al., 2019). In such practice contexts, the incorporation of the biocultural diversity concept was highly contested, for example, in the IPBES negotiations for the pollinator's assessment (Schmeller & Bridgewater, 2016). This might suggest that while on the one hand conceptual vagueness is necessary for boundary concepts to bridge, integrate and connect different disciplines, values, knowledge systems and practices (Steger et al., 2018), it can, on the other hand, lead to a lack of focus, cause misunderstandings and even jeopardize its application in policy and management.

4.3 | Sustainability solutions through biocultural approaches

At the core of sustainability science is the desire to provide actionable knowledge that can contribute to solving sustainability problems. Biocultural approaches can blend into such solution-oriented research in different regards. For example, they can serve for defining indicators of sustainability (Sterling et al., 2017) or facilitate transformational processes (Elands & van Koppen, 2012). In this review, we analysed how biocultural approaches linked to SDG. We selected the SDGs as one possible set of goals. The SDGs were approved in 2015 by the General Assembly of the United Nations and aim at updating a universal agenda, building upon the Millennium Development Goals, towards an integrated balance between the economic, social and environmental dimensions of sustainable development (UNGA, 2015). In our exploration of the relationships

between the biocultural literature and SDGs, SDG15 (i.e. to 'Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss') was most prominently linked to biocultural approaches. However, having only identified the main SDG related to each paper, our findings do not allow for a more nuanced overview of secondary links between biocultural approaches and SDGs. Interestingly, 28 papers did not relate, even indirectly, to any particular SDG. By that, our findings eventually reinforce Poole's (2018) idea that the SDGs still neglect fundamental qualities of cultural sovereignty, which are key in maintaining sustainable practices, values and lifestyle habits and that an 18th goal, which acknowledges biocultural heritage, should be included. It is argued that while sustainability is largely a matter of culture (Soini & Dessein, 2016), neither local ecological knowledge, cultural values and alternative economic practices, nor their interrelation with biodiversity are currently mentioned by any SDG in the pathway to sustainability (Poole, 2018). Instead, a universal agenda for sustainability should acknowledge and accommodate diverse worldviews and value systems around the notion of 'development' and alternative ways of framing nature–society relationships (Kopnina, 2016; Menton et al., 2020; Otero et al., 2020), within which biocultural approaches have even been posed as potential basis for the improvement of sustainability indicators (Sterling et al., 2017).

These findings are nuanced by the outcome that important issues particularly related to social sustainability and justice have not been extensively taken into account in the application of biocultural approaches thus far. Only two-thirds of the papers consider power and less than a quarter engage with gender issues, where gender is often connected to gendered knowledge and not to social justice-related issues. When it comes to engaging with sustainability solutions, two main types of studies in biocultural approaches can be distinguished. First, publications and lenses that more or less explicitly emphasize conservation as a key strategy for future engagement. Conservation focuses on the maintenance of different manifestations of traditional, indigenous or local human–nature relationships (particularly in the *conservation, history and heritage* and the *diversity* lenses) and often applies biocultural approaches as a descriptive and analytical entry point to investigate social–ecological systems. For example, biocultural diversity is often described empirically, under the premise that it has an intrinsic value, which needs to be preserved. Second, papers and lenses focus on transformation, that is, on leveraging biophysical and societal changes in a given social–ecological system to foster sustainability (e.g. *restoration*, *transformation and design* lens). Interestingly, many more papers (and lenses) tend to have a descriptive perspective on how a co-production of nature and culture has led to certain biocultural phenomena in the past and consequently emphasize a solution-oriented pathway to conservation. However, lenses rarely engage in a forward-looking perspective with action, transformation and a more dynamic and adaptive notion of biocultural approaches.

The different emphases of the lenses might be relevant for different situations, as they provide different entry points—some have greater salience to certain problems or decision contexts as compared to others. For example, in social–ecological systems subject to rapid environmental change, biocultural restoration may be the most suitable starting point, whereas in social–ecological systems, where the emphasis is on knowledge weaving and the rights of all people involved, a biocultural ethics framing may be more appropriate. However, the dominance of a 'nostalgic' perspective that is more centred around conservation might reduce the ability to adapt to future challenges. Also, the conservation focussed lenses tend towards a narrower problem framing and a more descriptive analysis, while the transformation point of view tends to take the broader perspective requiring systemic change for solving problems, thus emphasizing more strongly the dynamic nature of biocultural relationships. In this regard, the latter lenses are more representative of what sustainability science stands for—that is to take a systemic perspective to solve sustainability issues through transdisciplinary approaches. Our review suggests that biocultural approaches in sustainability science need to move from describing how nature and culture are co-produced to co-producing knowledge for sustainability solutions. For this, there is a need to take into account questions of power, gender and transformations, which has been largely neglected so far.

5 | CONCLUSIONS

Biocultural approaches embrace many features that render them suitable for application in sustainability science. They provide the conceptual and practical space for the inclusion of different academic disciplines and non-academic views and perspectives alike. However, biocultural approaches still lack mainstreaming of issues related to gender, power, action and transformations. More attention is needed in this regard in future applications in order to bring biocultural approaches to their full potential for sustainability science, so that they are not only implemented in an emancipatory and potentially transformative way in policy processes, but also in sustainability research.

ACKNOWLEDGEMENTS

J.H., I.D.-R. and A.D.-S. were funded through a social–ecological junior research group grant by the German Ministry for Education and Research (BMBF; 01UU1903). E.O.-R. has been funded by Juan de la Cierva Incorporation Fellowship of the Ministry of Science, Innovation and Universities (IJCI-2017-34334).

CONFLICT OF INTEREST

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

All authors reviewed the literature and coded the articles; A.S.O., N.M.G., C.M.R. and J.H. conducted the qualitative analysis; J.H. performed the quantitative analysis and prepared the figures. All authors contributed to the design and writing of the manuscript.

DATA AVAILABILITY STATEMENT

Data are available via the Dryad Digital Repository https://doi.org/10.5061/dryad.d51c5b007 (Hanspach et al., 2020). The 178 reviewed papers are listed in the Data Sources section.

ORCID

Jan Hanspach https://orcid.org/0000-0002-6638-8699
Lisbeth Jamila Haider https://orcid.org/0000-0002-0265-5356
Nora Fagerholm https://orcid.org/0000-0001-5020-0746

REFERENCES

Agnoletti, M., & Santoro, A. (2015). Cultural values and sustainable forest management: The case of Europe. *Journal of Forest Research*, *20*, 438–444. https://doi.org/10.1007/s10310-015-0500-7

Almada, E. D., & Coelho, M. S. (2015). The power of things without price: Traditional peoples and communities and the criticism of development. *Oecologia Australis*, *18*, 55–57. https://doi.org/10.4257/oeco.2014.1801.08

Apgar, J. M., Ataria, J. M., & Allen, W. J. (2011). Managing beyond designations: Supporting endogenous processes for nurturing biocultural development. *International Journal of Heritage Studies*, *17*, 555–570. https://doi.org/10.1080/13527258.2011.618250

Aston Philander, L. E., Makunga, N. P., & Platten, S. J. (2011). Local medicinal plant knowledge in South Africa preserved by apartheid. *Human Ecology*, *39*, 203–216. https://doi.org/10.1007/s10745-011-9387-x

Baggio, J. A., Brown, K., & Hellebrandt, D. (2015). Boundary object or bridging concept? A citation network analysis of resilience. *Ecology and Society*, *20*, 2. https://doi.org/10.5751/ES-07484-200202

Barthel, S., Crumley, C. L., & Svedin, U. (2013). Biocultural refugia: Combating the erosion of diversity in landscapes of food production. *Ecology and Society*, 18. https://doi.org/10.5751/ES-06207-180471

Brandt, P., Ernst, A., Gralla, F., Luederitz, C., Lang, D. J., Newig, J., … Von Wehrden, H. (2013). A review of transdisciplinary research in sustainability science. *Ecological Economics*, *92*, 1–15. https://doi.org/10.1016/j.ecolecon.2013.04.008

Bridgewater, P. B. (2002). Biosphere reserves: Special places for people and nature. *Environmental Science and Policy*, *5*, 9–12. https://doi.org/10.1016/S1462-9011(02)00018-7

Bridgewater, P., & Rotherham, I. D. (2019). A critical perspective on the concept of biocultural diversity and its emerging role in nature and heritage conservation. *People and Nature*, *1*, 291–304. https://doi.org/10.1002/pan3.10040

Brosius, J. P. P., & Hitchner, S. L. L. (2010). Cultural diversity and conservation. *International Social Science Journal*, *61*, 141–168. https://doi.org/10.1111/j.1468-2451.2010.01753.x

Buizer, M., Elands, B., & Vierikko, K. (2016). Governing cities reflexively—The biocultural diversity concept as an alternative to ecosystem services. *Environmental Science and Policy*, *62*, 7–13. https://doi.org/10.1016/j.envsci.2016.03.003

Caillon, S., Cullman, G., Verschuuren, B., & Sterling, E. J. (2017). Moving beyond the human–nature dichotomy through biocultural approaches: Including ecological well-being in resilience indicators. *Ecology and Society*, *22*, 27.

CBD. (1992). *Convention on biological diversity*. Rio de Janeiro, Brazil & New York, NY: United Nations.

Cevasco, R., Moreno, D., & Hearn, R. (2015). Biodiversification as an historical process: An appeal for the application of historical ecology to bio-cultural diversity research. *Biodiversity and Conservation*, *24*, 3167–3183. https://doi.org/10.1007/s10531-015-0943-3

Chan, K. M. A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., … Turner, N. (2016). Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences of the United States of America*, *113*, 1462–1465.

Ciftcioglu, G. C., Uzun, O., & Nemutlu, F. E. (2016). Evaluation of biocultural landscapes and associated ecosystem services in the region of Suğla Lake in Turkey. *Landscape Research*, *41*, 538–554. https://doi.org/10.1080/01426397.2016.1173659

Cocks, M. (2006). Biocultural diversity: Moving beyond the realm of 'indigenous' and 'local' people. *Human Ecology*, *34*, 185–200. https://doi.org/10.1007/s10745-006-9013-5

Cocks, M. L., Bangay, L., Wiersum, K. F., & Dold, A. P. (2006). Seeing the wood for the trees: The role of woody resources for the construction of gender specific household cultural artefacts in non-traditional communities in the Eastern Cape, South Africa. *Environment, Development and Sustainability*, *8*, 519–533. https://doi.org/10.1007/s10668-006-9053-4

Davidson-Hunt, I. J., Turner, K. L., Te Pareake Mead, A., Cabrera-Lopez, J., Bolton, R., Idrobo, C. J., … Robson, J. P. (2012). Biocultural design: A new conceptual framework for sustainable development in rural indigenous and local communities. *Sapiens*, *5*, 32–45.

Declaration of Belém. (1988). First International Congress of Ethnobiology. *International Society for Ethnobiology*. Retrieved from http://www.ethnobiology.net/wp-content/uploads/Decl-Belem-Eng-from-Posey.pdf

Díaz-Reviriego, I., Turnhout, E., & Beck, S. (2019). Participation and inclusiveness in the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. *Nature Sustainability*, *2*, 457–464. https://doi.org/10.1038/s41893-019-0290-6

Dunn, C. P. (2008). Biocultural diversity should be a priority for conservation. *Nature*, *456*, 315. https://doi.org/10.1038/456315c

Elands, B., & van Koppen, K. C. S. A. (2012). Biocultural diversity in the Netherlands: From ecologically noble savages towards biocultural creatives. In B. Arts, S. van Bommel, M. Ros-Tonen, & G. Verschoor (Eds.), *Forest-people interfaces: Understanding community forestry and biocultural diversity* (pp. 241–257). Wageningen, The Netherlands: Wageningen Academic Publishers.

Elands, B. H. M., Vierikko, K., Andersson, E., Fischer, L. K., Gonçalves, P., Haase, D., … Wiersum, K. F. (2018). Biocultural diversity: A novel concept to assess human–nature interrelations, nature conservation and stewardship in cities. *Urban Forestry and Urban Greening*, *40*, 29–34. https://doi.org/10.1016/j.ufug.2018.04.006

Ens, E. J., Pert, P., Clarke, P. A., Budden, M., Clubb, L., Doran, B., … Wason, S. (2015). Indigenous biocultural knowledge in ecosystem science and management: Review and insight from Australia. *Biological Conservation*, *181*, 133–149. https://doi.org/10.1016/j.biocon.2014.11.008

Ens, E., Scott, M. L., Rangers, Y. M., Moritz, C., & Pirzl, R. (2016). Putting indigenous conservation policy into practice delivers biodiversity and cultural benefits. *Biodiversity and Conservation*, *25*, 2889–2906. https://doi.org/10.1007/s10531-016-1207-6

Eser, U. (2009). Ethical perspectives on the preservation of biocultural diversity. *Bodenkultur*, *60*, 9–14.

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, *16*, 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Frascaroli, F. (2016). Shepherds, rituals, and the sacred. *Worldviews: Environment, Culture, Religion*, *20*, 272–285. https://doi.org/10.1163/15685357-02003005

Fukamachi, K., Miki, Y., Oku, H., & Miyoshi, I. (2011). The biocultural link: Isolated trees and hedges in Satoyama landscapes indicate a strong connection between biodiversity and local cultural features. *Landscape and Ecological Engineering*, *7*, 195–206. https://doi.org/10.1007/s11355-011-0164-1

González, J. A., Carvalho, A. M., Vallejo, J. R., & Amich, F. (2017). Plant-based remedies for wolf bites and rituals against wolves in the Iberian Peninsula: Therapeutic opportunities and cultural values for the

conservation of biocultural diversity. *Journal of Ethnopharmacology*, *209*, 124–139. https://doi.org/10.1016/j.jep.2017.07.038

Grant, C. (2012). Analogies and links between cultural and biological diversity. *Journal of Cultural Heritage Management and Sustainable Development*, *2*, 153–163. https://doi.org/10.1108/20441261211273644

Hanspach, J., Jamila Haider, L., Oteros-Rozas, E., Stahl Olafsson, A., Gulsrud, N. M., Raymond, C. M., … Plieninger, T. (2020). Data from: Biocultural approaches to sustainability: A systematic review of the scientific literature. *Dryad Digital Repository*, https://doi.org/10.5061/dryad.d51c5b007.

Heckenberger, M. J., Russell, J. C., Toney, J. R., & Schmidt, M. J. (2007). The legacy of cultural landscapes in the Brazilian Amazon: Implications for biodiversity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*, 197–208. https://doi.org/10.1098/rstb.2006.1979

Hill, R., Cullen-Unsworth, L. C., Talbot, L. D., & McIntyre-Tamwoy, S. (2011). Empowering Indigenous peoples' biocultural diversity through World Heritage cultural landscapes: A case study from the Australian humid tropical forests. *International Journal of Heritage Studies*, *17*, 571–591. https://doi.org/10.1080/13527258.2011.618252

Hill, R., Nates-Parra, G., Quezada-Euán, J. J. G., Buchori, D., LeBuhn, G., Maués, M. M., … Roué, M. (2019). Biocultural approaches to pollinator conservation. *Nature Sustainability*, *2*, 214–222. https://doi.org/10.1038/s41893-019-0244-z

Iniesta-Arandia, I., del Amo, D. G., García-Nieto, A. P., Piñeiro, C., Montes, C., & Martín-López, B. (2015). Factors influencing local ecological knowledge maintenance in Mediterranean watersheds: Insights for environmental policies. *Ambio*, *44*, 285–296. https://doi.org/10.1007/s13280-014-0556-1

IPBES. (2019). *The IPBES global assessment report on biodiversity and ecosystem services*. In E. S. Brondizio, S. Díaz, J. Settele, & H. T. Ngo (Eds.). Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., … Svedin, U. (2001). Sustainability science. *Science*, *292*, 641–642.

Kenter, J. O., Raymond, C. M., van Riper, C. J., Azzopardi, E., Brear, M. R., Calcagni, F., … Thankappan, S. (2019). Loving the mess: Navigating diversity and conflict in social values for sustainability. *Sustainability Science*, *14*, 1439–1461. https://doi.org/10.1007/s11625-019-00726-4

Kopnina, H. (2016). The victims of unsustainability: A challenge to sustainable development goals. *International Journal of Sustainable Development and World Ecology*, *23*, 113–121. https://doi.org/10.1080/13504509.2015.1111269

Kueffer, C., & Kinney, K. (2017). What is the importance of islands to environmental conservation? *Environmental Conservation*, *44*, 311–322. https://doi.org/10.1017/S0376892917000479

Kurashima, N., Jeremiah, J., & Ticktin, A. T. (2017). I Ka Wa Ma Mua: The value of a historical ecology approach to ecological restoration in Hawai'i. *Pacific Science*, *71*, 437–456.

Kuzivanova, V., & Davidson-Hunt, I. J. (2017). Biocultural design: Harvesting manomin with wabaseemoong independent nations. *Ethnobiology Letters*, *8*, 23–30. https://doi.org/10.14237/ebl.8.1.2017.794

Laird, S. A., Awung, G. L., Lysinge, R. J., & Ndive, L. E. (2011). The interweave of people and place: Biocultural diversity in migrant and indigenous livelihoods around Mount Cameroon. *International Forestry Review*, *13*, 275–293. https://doi.org/10.1505/146554811798293890

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., … Thomas, C. J. (2012). Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science*, *7*, 25–43. https://doi.org/10.1007/s11625-011-0149-x

Lezama-Núñez, P. R., Santos-Fita, D., & Vallejo, J. R. (2018). Herding ecologies and ongoing plant domestication processes in the Americas. *Frontiers in Plant Science*, *9*, 1–14. https://doi.org/10.3389/fpls.2018.00649

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., … Taylor, W. W. (2007). Complexity of coupled human and natural systems. *Science*, *317*, 1513–1516. https://doi.org/10.1126/science.1144004

Loh, J., & Harmon, D. (2005). A global index of biocultural diversity. *Ecological Indicators*, *5*, 231–241. https://doi.org/10.1016/j.ecolind.2005.02.005

Lyver, P. O. B., Akins, A., Phipps, H., Kahui, V., Towns, D. R., & Moller, H. (2016). Key biocultural values to guide restoration action and planning in New Zealand. *Restoration Ecology*, *24*, 314–323. https://doi.org/10.1111/rec.12318

Lyver, P. O., Wilmshurst, J. M., Wood, J. R., Jones, C. J., Fromont, M., Bellingham, P. J., … Moller, H. (2015). Looking back for the future: Local knowledge and palaeoecology inform biocultural restoration of coastal ecosystems in New Zealand. *Human Ecology*, *43*, 681–695. https://doi.org/10.1007/s10745-015-9784-7

Maffi, L. (2005). Linguistic, cultural, and biological diversity. *Annual Review of Anthropology*, *34*, 599–617. https://doi.org/10.1146/annurev.anthro.34.081804.120437

Maffi, L., & Woodley, E. (2010). *Biocultural diversity conservation: A global sourcebook*. London, UK: Earthscan.

Menton, M., Larrea, C., Latorre, S., Martinez-Alier, J., Peck, M., Temper, L., & Walter, M. (2020). Environmental justice and the SDGs: From synergies to gaps and contradictions. *Sustainability Science*. https://doi.org/10.1007/s11625-020-00789-8

Merçon, J., Vetter, S., Tengö, M., Cocks, M., Balvanera, P., Rosell, J. A., & Ayala-Orozco, B. (2019). From local landscapes to international policy: Contributions of the biocultural paradigm to global sustainability. *Global Sustainability*, *2*, E7. https://doi.org/10.1017/sus.2019.4

Miller, T. R., Wiek, A., Sarewitz, D., Robinson, J., Olsson, L., Kriebel, D., & Loorbach, D. (2014). The future of sustainability science: A solutions-oriented research agenda. *Sustainability Science*, *9*, 239–246. https://doi.org/10.1007/s11625-013-0224-6

Morishige, K., Andrade, P., Pascua, P., Steward, K., Cadiz, E., Kapono, L., & Chong, U. (2018). Nā Kilo ʻĀina: Visions of biocultural restoration through indigenous relationships between people and place. *Sustainability*, *10*, 3368.

Neulinger, K., Vogl, C. R., & Alayón-Gamboa, J. A. (2013). Plant species and their uses in homegardens of migrant maya and mestizo smallholder farmers in Calakmul, Campeche, Mexico. *Journal of Ethnobiology*, *33*, 105–124.

O'Neill, A. R., Badola, H. K., Dhyani, P. P., & Rana, S. K. (2017). Integrating ethnobiological knowledge into biodiversity conservation in the Eastern Himalayas. *Journal of Ethnobiology and Ethnomedicine*, *13*(1). https://doi.org/10.1186/s13002-017-0148-9

Otero, I., Farrell, K. N., Pueyo, S., Kallis, G., Kehoe, L., Haberl, H., … Pe'er, G. (2020). Biodiversity policy beyond economic growth. *Conservation Letters*, 1–18. https://doi.org/10.1111/conl.12713

Petrucci, N., Lema, V. S., Pochettino, M. L., Palamarczuk, V., Spano, R., & Tarragó, M. (2018). From weeds to wheat: A diachronic approach to ancient biocultural diversity in the Santa María valley, northwest Argentina. *Vegetation History and Archaeobotany*, *27*, 229–239. https://doi.org/10.1007/s00334-017-0647-6

Pfeiffer, J. M., & Voeks, R. A. (2008). Biological invasions and biocultural diversity: Linking ecological and cultural systems. *Environmental Conservation*, *35*, 281–293. https://doi.org/10.1017/S0376892908005146

Plieninger, T., Kizos, T., Bieling, C., Dû-Blayo, L. L., Budniok, M. A., Bürgi, M., … Verburg, P. H. (2015). Exploring ecosystem-change and society through a landscape lens: Recent progress in European landscape research. *Ecology and Society*, *20*, 5. https://doi.org/10.5751/ES-07443-200205

Plieninger, T., Kohsaka, R., Bieling, C., Hashimoto, S., Kamiyama, C., Kizos, T., … Saito, O. (2018). Fostering biocultural diversity in landscapes through place-based food networks: A 'solution scan' of European

and Japanese models. *Sustainability Science*, *13*, 219–233. https://doi.org/10.1007/s11625-017-0455-z

Polfus, J. L., Manseau, M., Simmons, D., Neyelle, M., Bayha, W., Andrew, F., … Wilson, P. (2016). Łeghágots'enetę (learning together): The importance of indigenous perspectives in the identification of biological variation. *Ecology and Society*, *21*, 18.

Polfus, J. L., Simmons, D., Neyelle, M., Bayha, W., Andrew, F., Andrew, L., … Manseau, M. (2017). Creative convergence: Exploring biocultural diversity through art. *Ecology and Society*, *22*, 4. https://doi.org/10.5751/ES-08711-220204

Poole, A. K. (2018). Where is goal 18? The need for biocultural heritage in the sustainable development goals. *Environmental Values*, *27*, 55–80. https://doi.org/10.3197/096327118X15144698637522

Pungetti, G. (2013). Biocultural diversity for sustainable ecological, cultural and sacred landscapes: The biocultural landscape approach. In B. Fu & K. B. Jones (Eds.), *Landscape ecology for sustainable environment and culture* (pp. 55–76). Cambridge, UK: Cambridge Centre for Landscape and People (CCLP), Darwin College, University of Cambridge.

Raymond, C. M., Kenter, J., Kendal, D., van Riper, C. J., & Rawluk, A. (2019). Editorial overview: Theoretical traditions in social values for sustainability. *Sustainability Science*, *14*, 1173–1185. https://doi.org/10.1007/s11625-019-00723-7

Robertson, D. P., & Hull, R. B. (2003). Biocultural ecology: Exploring the social construction of the Southern Appalachian Ecosystem. *Natural Areas Journal*, *23*, 180–189.

Rotherham, I. D. (2015). Bio-cultural heritage and biodiversity: Emerging paradigms in conservation and planning. *Biodiversity and Conservation*, *24*, 3405–3429. https://doi.org/10.1007/s10531-015-1006-5

Rozzi, R. (2012a). South American environmental philosophy: Ancestral Amerindian roots and emergent academic branches. *Environmental Ethics*, *34*, 343–366. https://doi.org/10.5840/enviroethics201234436

Rozzi, R. (2012b). Biocultural ethics: Recovering the vital links between the inhabitants, their habits, and habitats. *Environmental Ethics*, *34*, 27–50. https://doi.org/10.5840/enviroethics20123414

Rozzi, R., Massardo, F., Anderson, C. B., Heidinger, K., & Silander, Jr., J. A. (2006). Ten principles for biocultural conservation at the southern tip of the Americas: The approach of the Omora Ethnobotanical Park. *Ecology and Society*, *11*, 43. https://doi.org/10.5751/ES-01709-110143

Sadowski, R. F. (2017). Call for integral protection of biocultural diversity. *Problemy Ekorozwoju*, *12*, 37–45.

Samaddar, S. G., & Samaddar, A. B. (2010). Komal chaul – A potential candidate for geographical indication. *Journal of Intellectual Property Rights*, *15*, 214–219.

Schmeller, D. S., & Bridgewater, P. (2016). The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES): Progress and next steps. *Biodiversity and Conservation*, *25*, 801–805. https://doi.org/10.1007/s10531-016-1095-9

Singh, R. K., Srivastava, R. C., Padung, E., Rallen, O., & Taki, G. (2012). Biocultural value and conservation of 'tara' tree (Calamus erectus Roxb.) at biodiversity hot-spot: A study with Adi tribe of Arunachal Pradesh, India. *Indian Journal of Traditional Knowledge*, *11*, 514–519.

Soini, K., & Dessein, J. (2016). Culture–sustainability relation: Towards a conceptual framework. *Sustainability*, *8*, 13–15. https://doi.org/10.3390/su8020167

Srinivas, K. R. (2012). Protecting traditional knowledge holders' interests and preventing misappropriation—Traditional knowledge commons and biocultural protocols: Necessary but not sufficient? *International Journal of Cultural Property*, *19*, 401–422. https://doi.org/10.1017/S0940739112000252

Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, and Human Values*, *35*, 601–617. https://doi.org/10.1177/0162243910377624

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, *19*, 387–420. https://doi.org/10.1177/030631289019003001

Steger, C., Hirsch, S., Evers, C., Branoff, B., Petrova, M., Nielsen-Pincus, M., … van Riper, C. J. (2018). Ecosystem services as boundary objects for transdisciplinary collaboration. *Ecological Economics*, *143*, 153–160. https://doi.org/10.1016/j.ecolecon.2017.07.016

Stephenson, J., Berkes, F., Turner, N. J., & Dick, J. (2014). Biocultural conservation of marine ecosystems: Examples from New Zealand and Canada. *Indian Journal of Traditional Knowledge*, *13*, 257–265.

Stepp, J. R., Cervone, S., Castaneda, H., Lasseter, A., Stocks, G., & Gichon, Y. (2004). Development of a GIS for global biocultural diversity. *Policy Matters*, *13*, 267–270.

Sterling, E. J., Filardi, C., Toomey, A., Sigouin, A., Betley, E., Gazit, N., … Jupiter, S. D. (2017). Biocultural approaches to well-being and sustainability indicators across scales. *Nature Ecology and Evolution*, *1*, 1798–1806. https://doi.org/10.1038/s41559-017-0349-6

Tengö, M., Brondizio, E. S., Elmqvist, T., Malmer, P., & Spierenburg, M. (2014). Connecting diverse knowledge systems for enhanced ecosystem governance: The multiple evidence base approach. *Ambio*, *43*, 579–591. https://doi.org/10.1007/s13280-014-0501-3

Turner, K. L., Davidson-Hunt, I. J., & Hudson, I. (2018). Wine, cheese and building a gourmet territory: Biocultural resource-based development strategies in Bolivia. *Canadian Journal of Development Studies*, *39*, 19–37. https://doi.org/10.1080/02255189.2017.1331158

Turnhout, E., Bloomfield, B., Hulme, M., Vogel, J., & Wynne, B. (2012). Conservation policy: Listen to the voices of experience. *Nature*, *488*, 454–455. https://doi.org/10.1038/488454a

UNGA. (2015). *Transforming our world: The 2030 agenda for sustainable development*, New York, NY: resolution. United Nations General Assembly.

van Pelt, S. C., Haasnoot, M., Arts, B., Ludwig, F., Swart, R., & Biesbroek, R. (2015). Communicating climate (change) uncertainties: Simulation games as boundary objects. *Environmental Science and Policy*, *45*, 41–52. https://doi.org/10.1016/j.envsci.2014.09.004

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge, UK: Cambridge University Press.

Wiley, A. S., & Cullin, J. M. (2016). What do anthropologists mean when they use the term biocultural? *American Anthropologist*, *118*, 554–569.

Winter, K. B., Lincoln, N. K., & Berkes, F. (2018). The social–ecological keystone concept: A quantifiable metaphor for understanding the structure, function, and resilience of a biocultural system. *Sustainability*, *10*(9), 3294.

Wolverton, S. (2013). Ethnobiology 5: Interdisciplinarity in an era of rapid environmental change. *Ethnobiology Letters*, *4*, 21–25. https://doi.org/10.14237/ebl.4.2013.11

Wu, J. (2013). Landscape sustainability science: Ecosystem services and human well-being in changing landscapes. *Landscape Ecology*, *28*, 999–1023. https://doi.org/10.1007/s10980-013-9894-9

DATA SOURCES

Agnoletti, M., & Rotherham, I. D. (2015). Landscape and biocultural diversity. *Biodiversity and Conservation*, *24*, 3155–3165. https://doi.org/10.1007/s10531-015-1003-8

Agnoletti, M., & Santoro, A. (2015). Cultural values and sustainable forest management: The case of Europe. *Journal of Forest Research*, *20*, 438–444. https://doi.org/10.1007/s10310-015-0500-7

Agnoletti, M., Tredici, M., & Santoro, A. (2015). Biocultural diversity and landscape patterns in three historical rural areas of Morocco, Cuba and Italy. *Biodiversity and Conservation*, *24*, 3387–3404. https://doi.org/10.1007/s10531-015-1013-6

Alcántara-Salinas, G., Hunn, E. S., & Rivera-Hernández, J. E. (2015). Avian biodiversity in two Zapotec communities in Oaxaca: The role of community-based conservation in San Miguel Tiltepec and San Juan Mixtepec, Mexico. *Human Ecology*, *43*, 735–748. https://doi.org/10.1007/s10745-015-9777-6

Aldasoro Maya, E. M., & Gómez, B. (2016). Insects and other invertebrates in the Pjiekakjoo (Tlahuica) culture in Mexico State, Mexico. *Journal of Insects as Food and Feed*, *2*, 43–52.

Almada, E. D., & Coelho, M. S. (2015). The power of things without price: Traditional peoples and communities and the criticism of development. *Oecologia Australis*, *18*, 55–57. https://doi.org/10.4257/oeco.2014.1801.08

Amo-Rodríguez, S. D., Vergara-Tenorio, C. D., Ramos-Prado, J. M., & Porter-Bolland, L. (2010). Community landscape planning for rural areas: A model for biocultural resource management. *Society and Natural Resources*, *23*, 436–450. https://doi.org/10.1080/08941920802537781

Aniah, P., & Yelfaanibe, A. (2017). Environment, development and sustainability of local practices in the sacred groves and shrines in Bongo District: A bio-cultural study for environmental management in Ghana. *Environment, Development and Sustainability*, *1–13*.

Ankei, Y. (2012). Nuclear power plants and biocultural renaissance: A case study of Iwaishima Island in the Seto Inland Sea of Japan. *Journal of Marine and Island Cultures*, *1*, 126–130. https://doi.org/10.1016/j.imic.2012.12.001

Apgar, J. M., Ataria, J. M., & Allen, W. J. (2011). Managing beyond designations: Supporting endogenous processes for nurturing biocultural development. *International Journal of Heritage Studies*, *17*, 555–570. https://doi.org/10.1080/13527258.2011.618250

Arellanes, Y., Casas, A., Arellanes, A., Vega, E., Blancas, J., Vallejo, M., … Pérez-Negrón, E. (2013). Influence of traditional markets and interchange on plant management in the Tehuacan Valley. *Journal of Ethnobiology and Ethnomedicine*, *9*.

Arnaiz-Schmitz, C., Herrero-Jáuregui, C., & Schmitz, M. F. (2018). Losing a heritage hedgerow landscape. Biocultural diversity conservation in a changing social-ecological Mediterranean system. *Science of the Total Environment*, *637-638*, 374–384. https://doi.org/10.1016/j.scitotenv.2018.04.413

Arts, K., Rabelo, M. T., De Figueiredo, D. M., Maffey, G., Ioris, A. A., & Girard, P. (2018). Online and offline representations of biocultural diversity: A political ecology perspective on nature-based tourism and indigenous communities in the Brazilian Pantanal. *Sustainability (Switzerland)*, *10*, 1–20.

Aston Philander, L. E., Makunga, N. P., & Platten, S. J. (2011). Local medicinal plant knowledge in South Africa preserved by apartheid. *Human Ecology*, *39*, 203–216. https://doi.org/10.1007/s10745-011-9387-x

Athayde, S., & Silva-Lugo, J. (2018). Adaptive strategies to displacement and environmental change among the Kaiabi indigenous people of the Brazilian Amazon. *Society and Natural Resources*, *31*, 666–682. https://doi.org/10.1080/08941920.2018.1426801

Babai, D., Tóth, A., Szentirmai, I., Biró, M., Máté, A., Demeter, L., … Molnár, Z. (2015). Do conservation and agri-environmental regulations effectively support traditional small-scale farming in East-Central European cultural landscapes? *Biodiversity and Conservation*, *24*, 3305–3327.

Badola, H. K. (2017). Biocultural knowledge for biodiversity conservation: Some Himalayan endorsements. *Biodiversity*, *18*, 212–218. https://doi.org/10.1080/14888386.2017.1410444

Baiamonte, G., Domina, G., Raimondo, F. M., & Bazan, G. (2015). Agricultural landscapes and biodiversity conservation: A case study in Sicily (Italy). *Biodiversity and Conservation*, *24*, 3201–3216. https://doi.org/10.1007/s10531-015-0950-4

Baldy, C. R. (2013). Why we gather: Traditional gathering in native northwest California and the future of bio-cultural sovereignty. *Ecological Processes*, *2*, 1–10. https://doi.org/10.1186/2192-1709-2-17

Barthel, S., Crumley, C. L., & Svedin, U. (2013). Biocultural refugia: Combating the erosion of diversity in landscapes of food production. *Ecology and Society*, *18*. https://doi.org/10.5751/ES-06207-180471

Boillat, S., Mathez-Stiefel, S.-L., & Rist, S. (2013). Linking local knowledge, conservation practices and ecosystem diversity: Comparing two communities in the Tunari National Park (Bolivia). *Ethnobiology and Conservation*, *2*. https://doi.org/10.15451/ec2013-8-2.8-1-28

Bremer, L. L., Falinski, K., Ching, C., Wada, C. A., Burnett, K. M., Kukea-Shultz, K., … Ticktin, T. (2018). Biocultural restoration of traditional agriculture: cultural, environmental, and economic outcomes of Lo'i Kalo restoration in He'eia, O'ahu. *Sustainability*, *10*, 4502.

Brennan, R. E. (2018). Re-storying marine conservation: Integrating art and science to explore and articulate ideas, visions and expressions of marine space. *Ocean and Coastal Management*, *162*, 110–126. https://doi.org/10.1016/j.ocecoaman.2018.01.036

Bridgewater, P. B. (2002). Biosphere reserves: Special places for people and nature. *Environmental Science and Policy*, *5*, 9–12. https://doi.org/10.1016/S1462-9011(02)00018-7

Briggs, L., Stedman, R., & Krasny, M. (2018). Place attachment and social–ecological system sustainability examined through the voices of indigenous Guatemalan women. *Sustainability Science*, *14*, 655–667. https://doi.org/10.1007/s11625-018-0634-6

Brosius, J. P., & Hitchner, S. L. (2010). Cultural diversity and conservation. *International Social Science Journal*, *61*, 141–168. https://doi.org/10.1111/j.1468-2451.2010.01753.x

Buizer, M., Elands, B., & Vierikko, K. (2016). Governing cities reflexively – The biocultural diversity concept as an alternative to ecosystem services. *Environmental Science and Policy*, *62*, 7–13. https://doi.org/10.1016/j.envsci.2016.03.003

Caillon, S., Cullman, G., Verschuuren, B., & Sterling, E. J. (2017). Moving beyond the human–nature dichotomy through biocultural approaches: Including ecological well-being in resilience indicators. *Ecology and Society*, *22*(4), 27. https://doi.org/10.5751/ES-09746-220427

Baird Callicott, J., Rozzi, R., Delgado, L., Monticino, M., Acevedo, M., & Harcombe, P. (2007). Biocomplexity and conservation of biodiversity hotspots: Three case studies from the Americas. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*, 321–333. https://doi.org/10.1098/rstb.2006.1989

Calvet-Mir, L., Riu-Bosoms, C., González-Puente, M., Ruiz-Mallén, I., Reyes-García, V., & Molina, J. L. (2016). The transmission of home garden knowledge: Safeguarding biocultural diversity and enhancing social–ecological resilience. *Society and Natural Resources*, *29*, 556–571. https://doi.org/10.1080/08941920.2015.1094711

Cámara-Leret, R., Paniagua-Zambrana, N., Balslev, H., Barfod, A., Copete, J. C., & Macía, M. J. (2014). Ecological community traits and traditional knowledge shape palm ecosystem services in northwestern South America. *Forest Ecology and Management*, *334*, 28–42. https://doi.org/10.1016/j.foreco.2014.08.019

Celis-Diez, J. L., Muñoz, C. E., Abades, S., Marquet, P. A., & Armesto, J. J. (2017). Biocultural homogenization in urban settings: Public knowledge of birds in city parks of Santiago, Chile. *Sustainability (Switzerland)*, *9*. https://doi.org/10.3390/su9040485

Cevasco, R., Moreno, D., & Hearn, R. (2015). Biodiversification as an historical process: An appeal for the application of historical ecology to bio-cultural diversity research. *Biodiversity and Conservation*, *24*, 3167–3183. https://doi.org/10.1007/s10531-015-0943-3

Ciftcioglu, G. C., Uzun, O., & Nemutlu, F. E. (2016). Evaluation of biocultural landscapes and associated ecosystem services in the region of Suğla Lake in Turkey. *Landscape Research*, *41*, 538–554. https://doi.org/10.1080/01426397.2016.1173659

Cocks, M. (2006). Biocultural diversity: Moving beyond the realm of 'indigenous' and 'local' people. *Human Ecology*, *34*, 185–200. https://doi.org/10.1007/s10745-006-9013-5

Cocks, M., Alexander, J., Mogano, L., & Vetter, S. (2016). Ways of belonging: Meanings of 'Nature' among Xhosa-speaking township residents in South Africa. *Journal of Ethnobiology*, *36*, 820–841. https://doi.org/10.2993/0278-0771-36.4.820

Cocks, M. L., Bangay, L., Wiersum, K. F., & Dold, A. P. (2006). Seeing the wood for the trees: The role of woody resources for the construction of gender specific household cultural artefacts in non-traditional communities in the Eastern Cape, South Africa. *Environment, Development and Sustainability*, *8*, 519–533. https://doi.org/10.1007/s10668-006-9053-4

Cocks, M. L., & Dold, A. P. (2006). Cultural significance of biodiversity: The role of medicinal plants in urban African cultural practices in the Eastern Cape, South Africa of medicinal plants in urban African cultural. *Journal of Ethnobiology*, *26*, 60–81. https://doi.org/10.2993/0278-0771(2006)26[60:CSOBTR]2.0.CO;2

Cocks, M., Vetter, S., & Wiersum, K. F. (2018). From universal to local: Perspectives on cultural landscape heritage in South Africa. *International Journal of Heritage Studies*, *24*, 35–52. https://doi.org/10.1080/13527258.2017.1362573

Cocks, M. L., & Wiersum, F. (2014). Reappraising the concept of biocultural diversity: A perspective from South Africa. *Human Ecology*, *42*(5), 727–737. https://doi.org/10.1007/s10745-014-9681-5

Cuerrier, A. A., Turner, N. J., Gomes, T. C., Garibaldi, A., & Downing, A. (2015). Cultural keystone places: conservation and restoration in cultural landscapes. *Journal of Ethnobiology*, *35*, 427–448. https://doi.org/10.2993/0278-0771-35.3.427

Cumberbatch, J. A., & Hinds, C. J. (2013). Barbadian bio-cultural heritage: An analysis of the flying fish. *International Journal of Intangible Heritage*, *8*, 117–134.

Czembrowski, P., Łaszkiewicz, E., & Kronenberg, J. (2016). Bioculturally valuable but not necessarily worth the price: Integrating different dimensions of value of urban green spaces. *Urban Forestry and Urban Greening*, *20*, 89–96. https://doi.org/10.1016/j.ufug.2016.07.010

Davidson-Hunt, I. J., Turner, K. L., Mead, A. T., Cabrera-Lopez, J., Bolton, R., … Robson, J. P. (2012). Biocultural design: A new conceptual framework for sustainable development in rural indigenous and local communities. *Sapiens*, *5*, 32–45.

Dunn, C. P. (2008). Biocultural diversity should be a priority for conservation. *Nature*, *456*, 315. https://doi.org/10.1038/456315c

Elands, B., Vierikko, K., Andersson, E., Fischer, L. K., Gonçalves, P., Haase, D., … Wiersum, K. F. (2018). Biocultural diversity: A novel concept to assess human–nature interrelations, nature conservation and stewardship in cities. *Urban Forestry and Urban Greening*. https://doi.org/10.1016/j.ufug.2018.04.006

Elands, B. H. M., Wiersum, K. F., Buijs, A. E., & Vierikko, K. (2015). Policy interpretations and manifestation of biocultural diversity in urbanized Europe: Conservation of lived biodiversity. *Biodiversity and Conservation*, *24*, 3347–3366. https://doi.org/10.1007/s10531-015-0985-6

Ens, E. J., Pert, P., Clarke, P. A., Budden, M., Clubb, L., Doran, B., … Wason, S. (2015). Indigenous biocultural knowledge in ecosystem science and management: Review and insight from Australia. *Biological Conservation*, *181*, 133–149. https://doi.org/10.1016/j.biocon.2014.11.008

Ens, E., Scott, M. L., Rangers, Y. M., Moritz, C., & Pirzl, R. (2016). Putting indigenous conservation policy into practice delivers biodiversity and cultural benefits. *Biodiversity and Conservation*, *25*, 2889–2906. https://doi.org/10.1007/s10531-016-1207-6

Eriksson, O. (2018). What is biological cultural heritage and why should we care about it? An example from Swedish rural landscapes and forests. *Nature Conservation*, *28*, 1–32. https://doi.org/10.3897/natureconservation.28.25067

Eser, U. (Ed.) (2009). Ethical perspectives on the preservation of biocultural diversity. *Die Bodenkultur*, *60*(1), 9–14.

Fernández-Llamazares, Á., & Cabeza, M. (2017). Rediscovering the potential of indigenous storytelling for conservation practice. *Conservation Letters*. https://doi.org/10.1111/conl.12398

Franco, F., Ghani, B. A., & Hidayati, S. (2014). Biocultural importance of the tanying [*Koompassia excelsa* (Becc.) taub.] tree for the Berawan of loagan bunut, Sarawak, Malaysia. *Indian Journal of Traditional Knowledge*, *13*, 63–69.

Frascaroli, F. (2016). Shepherds, rituals, and the sacred. *Worldviews: Environment, Culture, Religion*, *20*, 272–285.

Frascaroli, F., Bhagwat, S., Guarino, R., Chiarucci, A., & Schmid, B. (2016). Shrines in Central Italy conserve plant diversity and large trees. *Ambio*, *45*, 468–479. https://doi.org/10.1007/s13280-015-0738-5

Fukamachi, K., Miki, Y., Oku, H., & Miyoshi, I. (2011). The biocultural link: Isolated trees and hedges in Satoyama landscapes indicate a strong connection between biodiversity and local cultural features. *Landscape and Ecological Engineering*, *7*, 195–206. https://doi.org/10.1007/s11355-011-0164-1

Furusawa, T., Sirikolo, M., Sasaoka, M., & Ohtsuka, R. (2014). Interaction between forest biodiversity and people's use of forest resources in Roviana, Solomon Islands: Implications for biocultural conservation under socioeconomic changes Interaction between forest biodiversity and people's use of forest resource. *Journal of Ethnobiology and Ethnomedicine*, *10*(1), 1–20. https://doi.org/10.1186/1746-4269-10-10

Gama, A. D. S., de Paula, M., da Silva, R. R. V., Ferreira, W. S., & de Medeiros, P. M. (2018). Exotic species as models to understand biocultural adaptation: Challenges to mainstream views of human–nature relations. *PLoS ONE*, *13*. https://doi.org/10.1371/journal.pone.0196091

Gavin, M. C., McCarter, J., Mead, A., Berkes, F., Stepp, J. R., Peterson, D., & Tang, R. (2015). Defining biocultural approaches to conservation. *Trends in Ecology & Evolution*, *30*(3), 140–145.

Gavin, M. C., McCarter, J., Berkes, F., Mead, A. T., Sterling, E. J., Tang, R., & Turner, N. J. (2018). Effective biodiversity conservation requires dynamic, pluralistic, partnership-based approaches. *Sustainability (Switzerland)*, *10*, 1–11.

Gilmore, M. P., & Young, J. C. (2012). The use of participatory mapping in ethnobiological research, biocultural conservation, and community empowerment: A case study from the Peruvian Amazon. *Journal of Ethnobiology*, *32*, 6–29. https://doi.org/10.2993/0278-0771-32.1.6

Gon, S. M., Tom, S. L., & Woodside, U. (2018). 'Āina Momona, Honua Au loli-productive lands, changing world: Using the Hawaiian footprint to inform biocultural restoration and future sustainability in Hawai'i. *Sustainability (Switzerland)*, *10*.

González, J. A., Carvalho, A. M., Vallejo, J. R., & Amich, F. (2017). Plant-based remedies for wolf bites and rituals against wolves in the Iberian Peninsula: Therapeutic opportunities and cultural values for the conservation of biocultural diversity. *Journal of Ethnopharmacology*, *209*, 124–139. https://doi.org/10.1016/j.jep.2017.07.038

Gottero, E., & Cassatella, C. (2017). Landscape indicators for rural development policies. Application of a core set in the case study of Piedmont Region. *Environmental Impact Assessment Review*, *65*, 75–85. https://doi.org/10.1016/j.eiar.2017.04.002

Graddy, T. G. (2013). Regarding biocultural heritage: In situ political ecology of agricultural biodiversity in the Peruvian Andes. *Agriculture and Human Values*, *30*, 587–604. https://doi.org/10.1007/s10460-013-9428-8

Grant, C. (2012). Analogies and links between cultural and biological diversity. *Journal of Cultural Heritage Management and Sustainable Development*, *2*, 153–163. https://doi.org/10.1108/20441261211273644

Harmon, D. (2007). A bridge over the chasm: Finding ways to achieve integrated natural and cultural heritage conservation. *International Journal of Heritage Studies*, *13*, 380–392. https://doi.org/10.1080/13527250701351098

Hay-Edie, T., Howard, P., Martin, G., & McCandless, S. (2011). The roles of local, national and international designations in conserving biocultural diversity on a landscape scale. *International Journal of Heritage Studies*, *17*, 527–536. https://doi.org/10.1080/13527258.2011.618244

Heckenberger, M. J., Russell, J. C., Toney, J. R., & Schmidt, M. J. (2007). The legacy of cultural landscapes in the Brazilian Amazon: Implications for biodiversity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*, 197–208. https://doi.org/10.1098/rstb.2006.1979

Hill, R., Cullen-Unsworth, L. C., Talbot, L. D., & McIntyre-Tamwoy, S. (2011). Empowering Indigenous peoples' biocultural diversity through World Heritage cultural landscapes: A case study from the Australian humid tropical forests. *International Journal of Heritage Studies*, *17*, 571–591. https://doi.org/10.1080/13527258.2011.618252

Hirons, M., Boyd, E., McDermott, C., Asare, R., Morel, A., Mason, J., … Norris, K. (2018). Understanding climate resilience in Ghanaian cocoa communities – Advancing a biocultural perspective. *Journal of Rural Studies*, *63*, 120–129. https://doi.org/10.1016/j.jrurstud.2018.08.010

Hong, S.-K. (2010). Island ecology on biological-cultural diversities and human adaptation in seascapes. *Journal of Ecology and Field Biology*, *33*, 115–120.

Hong, S.-K. (2011). Biocultural diversity and traditional ecological knowledge in island regions of Southwestern Korea. *Journal of Ecology and Field Biology*, *34*, 137–147.

Hong, S.-K. (2012). Tidal-flat islands in Korea: Exploring biocultural diversity. *Journal of Marine and Island Cultures*, *1*, 11–20. https://doi.org/10.1016/j.imic.2012.04.001

Hong, S.-K. (2013). Biocultural diversity conservation for island and islanders: Necessity, goal and activity. *Journal of Marine and Island Cultures*, *2*, 102–106. https://doi.org/10.1016/j.imic.2013.11.004

Ianni, E., Silva Rivera, E., & Geneletti, D. (2014). Sustaining cultural and biological diversity in rapidly changing communities: The revitalization of the Voladores ritual in northern Veracruz (Mexico). *Environment, Development and Sustainability*, *16*, 1197–1208. https://doi.org/10.1007/s10668-014-9520-2

Iniesta-Arandia, I., del Amo, D. G., García-Nieto, A. P., Piñeiro, C., Montes, C., & Martín-López, B. (2015). Factors influencing local ecological knowledge maintenance in Mediterranean watersheds: Insights for environmental policies. *Ambio*, *44*, 285–296. https://doi.org/10.1007/s13280-014-0556-1

Johns, T., & Sthapit, B. R. (2004). Biocultural diversity in the sustainability of developing-country food systems. *Food and Nutrition Bulletin*, *25*, 143–155. https://doi.org/10.1177/156482650402500207

Johnston, B. R. (2013). Human needs and environmental rights to water: A biocultural systems approach to hydrodevelopment and management. *Ecosphere*, *4*, 1–15. https://doi.org/10.1890/ES12-00370.1

Kagawa-Viviani, A., Levin, P., Johnston, E., Ooka, J., Baker, J., Kantar, M., & Lincoln, N. K. (2018). I Ke Ēwe Āina o Ke kupuna: Hawaiian ancestral crops in perspective. *Sustainability (Switzerland)*, *10*, 1–36.

Kieninger, P., Holzner, W., & Kriechbaum, M. (2009). Biocultural diversity and satoyama. Emotions and the fun-factor in nature conservation – A lesson from Japan. *Bodenkultur*, *60*, 15–21.

Kieninger, P. R., Penker, M., & Yamaji, E. (2013). Esthetic and spiritual values motivating collective action for the conservation of cultural landscape – A case study of rice terraces in Japan. *Renewable Agriculture and Food Systems*, *28*, 364–379. https://doi.org/10.1017/S1742170512000269

Kikiloi, K., Friedlander, A. M., Wilhelm, A., Lewis, N., Quiocho, K., 'Āila, W., & Kaho'ohalahala, S. (2017). Papahānaumokuākea: Integrating culture in the design and management of one of the world's largest marine protected areas. *Coastal Management*, *45*, 436–451. https://doi.org/10.1080/08920753.2017.1373450

Kim, J.-E. (2015). Rural landscape and biocultural diversity in Shinan-gun, Jeollanam-do, Korea. *Journal of Ecology and Environment*, *38*, 249–256. https://doi.org/10.5141/ecoenv.2015.025

Kodis, M., Galante, P., Sterling, E. J., & Blair, M. E. (2018). Ecological niche modeling for a cultivated plant species: A case study on taro (*Colocasia esculenta*) in Hawaii. *Ecological Applications*, *28*, 967–977.

Kueffer, C., & Kinney, K. (2017). What is the importance of islands to environmental conservation? *Environmental Conservation*, *44*, 311–322.

Kurashima, N., Jeremiah, J., & Ticktin, A. T. (2017). I Ka Wa Ma Mua: The value of a historical ecology approach to ecological restoration in Hawai'i. *Pacific Science*, *71*, 437–456.

Kurashima, N., Jeremiah, J., Whitehead, A., Tulchin, J., Browning, M., & Duarte, T. (2018). 'Āina Kaumaha: The maintenance of ancestral principles for 21st century indigenous resource management. *Sustainability (Switzerland)*, *10*, 1–21. https://doi.org/10.3390/su10113975

Kuzivanova, V., & Davidson-Hunt, I. J. (2017). Biocultural design: Harvesting manomin with wabaseemoong independent nations. *Ethnobiology Letters*, *8*, 23–30. https://doi.org/10.14237/ebl.8.1.2017.794

Laird, S. A., Awung, G. L., Lysinge, R. J., & Ndive, L. E. (2011). The interweave of people and place: Biocultural diversity in migrant and indigenous livelihoods around Mount Cameroon. *International Forestry Review*, *13*, 275–293. https://doi.org/10.1505/146554811798293890

Langston, B. J., & Lincoln, N. K. (2018). The role of breadfruit in biocultural restoration and sustainability in Hawai'i. *Sustainability (Switzerland)*, *10*, 1–17. https://doi.org/10.3390/su10113965

Latocha, A., Reczyńska, K., Gradowski, T., & Świerkosz, K. (2018). Landscape memory in abandoned areas – Physical and ecological perspectives (Central European mountains case study). *Landscape Research*, *44*, 600–613. https://doi.org/10.1080/01426397.2018.1493446

Latorre, E. C., Canavero, A., & Pochettino, M. L. (2018). Comparison of medicinal plant knowledge between rural and urban people living in the Biosphere Reserve 'Bioma Pampa-Quebradas del Norte', Uruguay: An opportunity for biocultural conservation. *Ethnobiology and Conservation*, *7*.

Lezama-Núñez, P. R., Santos-Fita, D., & Vallejo, J. R. (2018). Herding ecologies and ongoing plant domestication processes in the Americas. *Frontiers in Plant Science*, *9*, 1–14. https://doi.org/10.3389/fpls.2018.00649

Kekuewa Lincoln, N., Rossen, J., Vitousek, P., Kahoonei, J., Shapiro, D., Kalawe, K., …Meheula, K. (2018). Restoration of 'āina malo'o on Hawai'i island: Expanding biocultural relationships. *Sustainability (Switzerland)*, *10*, 1–22.

Loh, J., & Harmon, D. (2005). Global index of biocultural diversity. *Ecological Indicators*, *5*, 231–241.

Lyver, P. O'. B., Akins, A., Phipps, H., Kahui, V., Towns, D. R., & Moller, H. (2016). Key biocultural values to guide restoration action and planning in New Zealand. *Restoration Ecology*, *24*, 314–323. https://doi.org/10.1111/rec.12318

Lyver, P. O'. B., Wilmshurst, J. M., Wood, J. R., Jones, C. J., Fromont, M., Bellingham, P. J., … Moller, H. (2015). Looking back for the future: Local knowledge and palaeoecology inform biocultural restoration of coastal ecosystems in New Zealand. *Human Ecology*, *43*, 681–695. https://doi.org/10.1007/s10745-015-9784-7

Maffi, L. (2005). Linguistic, cultural, and biological diversity. *Annual Review of Anthropology*, *34*, 599–617. https://doi.org/10.1146/annurev.anthro.34.081804.120437

Makhzoumi, J., Chmaitelly, H., & Lteif, C. (2012). Holistic conservation of bio-cultural diversity in coastal Lebanon: A landscape approach. *Journal of Marine and Island Cultures*, *1*, 27–37. https://doi.org/10.1016/j.imic.2012.04.003

Mao, S., Shen, Y., & Deng, H. (2018). Multipurpose plant utilization in ethnic areas of Guizhou, southwest China. *Ecological Indicators*, *90*, 547–553. https://doi.org/10.1016/j.ecolind.2018.03.064

Mauerhofer, V., Ichinose, T., Blackwell, B. D., Willig, M. R., Flint, C. G., Krause, M. S., & Penker, M. (2018). Underuse of social–ecological systems: A research agenda for addressing challenges to biocultural diversity. *Land Use Policy*, *72*, 57–64. https://doi.org/10.1016/j.landusepol.2017.12.003

McCarter, J., Sterling, E. J., Jupiter, S. D., Cullman, G. D., Albert, S., Basi, M., … Filardi, C. E. (2018). Biocultural approaches to developing well-being indicators in Solomon Islands. *Ecology and Society*, *23*. https://doi.org/10.5751/ES-09867-230132

Mishra, S., Chaudhury, S. S., & Nambi, V. A. (2013). Sustaining rice landraces in-situ and on farm through biocultural diversity in Koraput, Odisha, India. *Asian Agri-History*, *17*, 123–139.

Mooij, M. L. J., Mendonça, S. D., & Arts, K. (2018). Conserving biocultural diversity through community-government interaction: A practice-based approach in a Brazilian extractive reserve. *Sustainability (Switzerland)*, *11*. https://doi.org/10.3390/su11010032

Morishige, K., Andrade, P., Pascua, P., Steward, K., Cadiz, E., Kapono, L., & Chong, U. (2018). Nā Kilo 'Āina: Visions of biocultural restoration through indigenous relationships between people and place. *Sustainability (Switzerland)*, *10*, 1–20.

Musacchio, L. R. (2011). The world's matrix of vegetation: Hunting the hidden dimension of landscape sustainability. *Landscape and Urban Planning*, *100*, 356–360. https://doi.org/10.1016/j.landurbplan.2011.01.014

Nabhan, G. P., Walker, D., & Moreno, A. M. (2010). Biocultural and ecogastronomic restoration: The renewing America's food traditions alliance. *Ecological Restoration*, *28*, 266–279. https://doi.org/10.3368/er.28.3.266

Nahuelhual, L., Carmona, A., Laterra, P., Barrena, J., & Aguayo, M. (2014). A mapping approach to assess intangible cultural ecosystem services: The case of agriculture heritage in Southern Chile. *Ecological Indicators*, *40*, 90–101. https://doi.org/10.1016/j.ecolind.2014.01.005

Nebel, S., & Heinrich, M. (2009). Ta Chòrta: A comparative ethnobotanical-linguistic study of wild food plants in a graecanic area in Calabria, Southern Italy. *Economic Botany*, *63*, 78–92. https://doi.org/10.1007/s12231-008-9069-9

Neulinger, K., Vogl, C. R., & Alayón-Gamboa, J. A. (2013). Plant species and their uses in homegardens of migrant maya and *Mestizo* smallholder farmers in Calakmul, Campeche, Mexico. *Journal of Ethnobiology*, *33*, 105–124.

Ohsawa, M., & Kitazawa, T. (2009). Biocultural diversity and functional integrity of Japan's rural landscape. *Bodenkultur*, *60*, 31–40.

Okano, T., & Matsuda, H. (2013). Biocultural diversity of Yakushima Island: Mountains, beaches, and sea. *Journal of Marine and Island Cultures*, *2*, 69–77. https://doi.org/10.1016/j.imic.2013.11.008

O'Neill, A. R., Badola, H. K., Dhyani, P. P., & Rana, S. K. (2017). Integrating ethnobiological knowledge into biodiversity conservation in the Eastern Himalayas. *Journal of Ethnobiology and Ethnomedicine*, *13*, 1–14. https://doi.org/10.1186/s13002-017-0148-9

O'Neill, A. R., & Rana, S. K. (2016). An ethnobotanical analysis of parasitic plants (Parijibi) in the Nepal Himalaya. *Journal of Ethnobiology and Ethnomedicine*, *12*, 1–15. https://doi.org/10.1186/s13002-016-0086-y

Pástor, M., Slámová, M., & Benčať, T. (2017). The distribution and biocultural value assessment of sweet chestnut (*Castanea sativa* Mill.) in the cadastral districts of stredné plachtince and horné plachtince (Slovakia). *Ekologia Bratislava*, *36*, 130–145. https://doi.org/10.1515/eko-2017-0012

Pert, P. L., Hill, R., Maclean, K., Dale, A., Rist, P., Schmider, J., … Tawake, L. (2015). Mapping cultural ecosystem services with rainforest aboriginal peoples: Integrating biocultural diversity, governance and social variation. *Ecosystem Services*, *13*, 41–56. https://doi.org/10.1016/j.ecoser.2014.10.012

Petrucci, N., Lema, V. S., Pochettino, M. L., Palamarczuk, V., Spano, R., & Tarragó, M. (2018). From weeds to wheat: A diachronic approach to ancient biocultural diversity in the Santa María valley, northwest Argentina. *Vegetation History and Archaeobotany*, *27*, 229–239. https://doi.org/10.1007/s00334-017-0647-6

Pfeiffer, J. M., Dun, S., Mulawarman, B., & Rice, K. J. (2006). Biocultural diversity in traditional rice-based agroecosystems: Indigenous research and conservation of mavo (*Oryza sativa* L.) upland rice landraces of eastern Indonesia. *Environment, Development and Sustainability*, *8*, 609–625. https://doi.org/10.1007/s10668-006-9047-2

Pfeiffer, J. M., & Voeks, R. A. (2008). Biological invasions and biocultural diversity: Linking ecological and cultural systems. *Environmental Conservation*, *35*, 281. https://doi.org/10.1017/S0376892908005146

Pieroni, A., & Sõukand, R. (2018). Forest as stronghold of local ecological practice: currently used wild food plants in Polesia, Northern Ukraine. *Economic Botany*, *72*, 311–331. https://doi.org/10.1007/s12231-018-9425-3

Plieninger, T., Kohsaka, R., Bieling, C., Hashimoto, S., Kamiyama, C., Kizos, T., … Saito, O. (2018). Fostering biocultural diversity in landscapes through place-based food networks: A 'solution scan' of European and Japanese models. *Sustainability Science*, *13*, 219–233. https://doi.org/10.1007/s11625-017-0455-z

Polfus, J., Manseau, M., & Simmons, D. (2016). Łeghágots'enetę (learning together): The importance of indigenous perspectives in the identification of biological variation. *Ecology and Society*, *21*.

Polfus, J. L., Simmons, D., Neyelle, M., Bayha, W., Andrew, F., Andrew, L., … Manseau, M. (2017). Creative convergence: Exploring biocultural diversity through art. *Ecology and Society*, *22*. https://doi.org/10.5751/ES-08711-220204

Poole, A. K. (2018). Where is goal 18? The need for biocultural heritage in the sustainable development goals. *Environmental Values*, *27*, 55–80. https://doi.org/10.3197/096327118X15144698637522

Pungetti, G. (2012). Islands, culture, landscape and seascape. *Journal of Marine and Island Cultures*, *1*, 51–54. https://doi.org/10.1016/j.imic.2012.11.007

Rangel-Landa, S., Casas, A., Rivera-Lozoya, E., Torres-García, I., & Vallejo-Ramos, M. (2016). Ixcatec ethnoecology: Plant management and biocultural heritage in Oaxaca, Mexico. *Journal of Ethnobiology and Ethnomedicine*, *12*. https://doi.org/10.1186/s13002-016-0101-3

Robertson, D. P., & Hull, R. B. (2003). Biocultural Ecology: Exploring the social construction of the Southern Appalachian ecosystems. *Natural Areas Journal*, *23*, 180–189.

Robertson, D. P., & Hull, R. B. (2003). Public ecology: An environmental science and policy for global society. *Environmental Science and Policy*, *6*, 399–410. https://doi.org/10.1016/S1462-9011(03)00077-7

Rotherham, I. D. (2015). Bio-cultural heritage and biodiversity: Emerging paradigms in conservation and planning. *Biodiversity and Conservation*, *24*, 3405–3429. https://doi.org/10.1007/s10531-015-1006-5

Rozzi, R. (2012). Biocultural ethics: Recovering the vital links between the inhabitants, their habits, and habitats. *Environmental Ethics*, *34*, 27–50. https://doi.org/10.5840/enviroethics20123414

Rozzi, R. (2012). South American environmental philosophy: Ancestral Amerindian roots and emergent academic branches. *Environmental Ethics*, *34*, 343–366. https://doi.org/10.5840/enviroethics201234436

Rozzi, R., Arango, X., Massardo, F., Anderson, C., Heidinger, K., & Moses, K. (2008). Field environmental philosophy and biocultural conservation: The Omora Ethnobotanical Park Educational Program. *Environmental Ethics*, *30*, 115–125.

Rozzi, R., Armesto, J. J., Gutiérrez, J. R., Massardo, F., Likens, G. E., Anderson, C. B., … Arroyo, M. T. K. (2012). Integrating ecology and environmental ethics: Earth stewardship in the southern end of the Americas. *BioScience*, *62*, 226–236. https://doi.org/10.1525/bio.2012.62.3.4

Rozzi, R., & Massardo, F. (2011). The road to biocultural ethics. *Frontiers in Ecology and the Environment*, *9*, 246–247. https://doi.org/10.1890/1540-9295-9.4.246

Rozzi, R., Massardo, F., Anderson, C. B., Heidinger, K., & Silander, Jr. J. A. (2006). Ten principles for biocultural conservation at the southern tip of the Americas: The approach of the Omora Ethnobotanical Park. *Ecology and Society*, *11*. https://doi.org/10.5751/ES-01709-110143

Ryan, J. C. (2014). Natural heritage conservation and eco-digital poiesis: A Western Australian example. *Media International Australia*, *153*, 88–97. https://doi.org/10.1177/1329878X1415300111

Sadowski, R. F. (2017). Call for integral protection of biocultural diversity. *Problemy Ekorozwoju*, *12*, 37–45.

Salisbury, D. S., & Weinstein, B. G. (2014). Cultural diversity in the Amazon Borderlands: Implications for conservation and development. *Journal of Borderlands Studies*, *29*, 217–241. https://doi.org/10.1080/08865655.2014.916462

Samaddar, S. G., & Samaddar, A. B. (2010). Komal chaul – A potential candidate for geographical indication. *Journal of Intellectual Property Rights*, *15*, 214–219.

Samakov, A., & Berkes, F. (2017). Spiritual commons: Sacred sites as core of community-conserved areas in Kyrgyzstan. *International Journal of the Commons*, *11*, 422–444. https://doi.org/10.18352/ijc.713

Sanz-Cañada, J., & Muchnik, J. (2016). Geographies of origin and proximity: Approaches to local agro-food systems. *Culture & History Digital Journal*, *5*, e002. https://doi.org/10.3989/chdj.2016.002

Sarmiento, F. O., Ibarra, J. T., Barreau, A., Pizarro, J. C., Rozzi, R., González, J. A., & Frolich, L. M. (2017). Applied montology using critical biogeography in the Andes. *Annals of the American Association of Geographers*, *107*, 416–428. https://doi.org/10.1080/24694452.2016.1260438

Sayre, M., Stenner, T., & Argumedo, A. (2017). You can't grow potatoes in the sky: Building resilience in the face of climate change in the Potato Park of Cuzco, Peru. *Culture, Agriculture, Food and Environment*, *39*, 100–108. https://doi.org/10.1111/cuag.12100

Shackleton, C. M., Ticktin, T., & Cunningham, A. B. (2018). Nontimber forest products as ecological and biocultural keystone species. *Ecology and Society*, *23*. https://doi.org/10.5751/ES-10469-230422

Shultis, J., & Heffner, S. (2016). Hegemonic and emerging concepts of conservation: A critical examination of barriers to incorporating Indigenous perspectives in protected area conservation policies and practice. *Journal of Sustainable Tourism*, *24*, 1227–1242. https://doi.org/10.1080/09669582.2016.1158827

Sillitoe, P., Alshawi, A. A., & Al-Amir Hassan, A. K. (2010). Challenges to conservation: Land use change and local participation in the Al Reem Biosphere Reserve, West Qatar. *Journal of Ethnobiology and Ethnomedicine*, *6*. https://doi.org/10.1186/1746-4269-6-28

Singh, R. K., Alves, R. N., & Ralen, O. (2014). Hunting of kebung (*Ratufa bicolor*) and other squirrel species from morang forest by the Adi tribe of Arunachal Pradesh, India: Biocultural conservation and livelihood dimensions. *Regional Environmental Change*, *14*, 1479–1490. https://doi.org/10.1007/s10113-014-0590-3

Singh, R. K., & Padung, I. (2010). Climate change, REDD and biocultural diversity: Consultation and grassroots initiatives with Indigenous People of Arunachal Pradesh. *Current Science*, *99*, 421–422.

Singh, R. K., Rallen, O., & Padung, E. (2013). Elderly adi women of Arunachal Pradesh: 'Living Encyclopedias' and cultural refugia in biodiversity conservation of the Eastern Himalaya, India. *Environmental Management*, *52*, 712–735. https://doi.org/10.1007/s00267-013-0113-x

Singh, R. K., Singh, A., & Tag, H. (2008). Traditional skill among the Adi tribes of Arunachal Pradesh. *Indian Journal of Traditional Knowledge*, *7*, 27–36.

Singh, R. K., Singh, A., & Bhardwaj, R. (2012). Namdung (*Perilla ocymoides*): A bioculturally rich plant in food and livelihood security of Adi women in Arunachal Pradesh, Eastern Himalaya. *Indian Journal of Traditional Knowledge*, *11*, 143–149.

Singh, R. K., & Srivastava, R. C. (2009). Biocultural knowledge and Adi community: Conservation and sustainability in biodiversity hotspot of Arunachal Pradesh. *Current Science*, *96*, 883–884.

Singh, R. K., Srivastava, R. C., Padung, E., Rallen, O., & Taki, G. (2012). Biocultural value and conservation of 'tara' tree (*Calamus erectus* Roxb.) at biodiversity hot-spot: A study with Adi tribe of Arunachal Pradesh, India. *Indian Journal of Traditional Knowledge*, *11*, 514–519.

Singh, R. K., Srivastava, R. C., Pandey, C. B., & Singh, A. (2015). Tribal institutions and conservation of the bioculturally valuable 'tasat' (*Arenga obtusifolia*) tree in the eastern Himalaya. *Journal of Environmental Planning and Management*, *58*, 69–90.

Srinivas, K. R. (2012). Protecting traditional knowledge holders' interests and preventing misappropriation – Traditional knowledge commons and biocultural protocols: Necessary but not sufficient? *International Journal of Cultural Property*, *19*, 401–422.

Srivastava, R. C., Singh, R. K., & Mukherjee, T. K. (2010). Bioculturally important rare new plant species of Heteropanax seems (Araliaceae) from Eastern Himalaya, Arunachal Pradesh. *Indian Journal of Traditional Knowledge*, *9*, 242–244.

Srivastava, R. C., Singh, R. K., & Mukherjee, T. K. (2010). Indigenous biodiversity of Apatani plateau: Learning on biocultural knowledge of Apatani tribe of Arunachal Pradesh for sustainable livelihoods. *Indian Journal of Traditional Knowledge*, *9*, 432–442.

Stephenson, J., Berkes, F., Turner, N. J., & Dick, J. (2014). Biocultural conservation of marine ecosystems: Examples from New Zealand and Canada. *Indian Journal of Traditional Knowledge*, *13*, 257–265.

Stepp, J. R., Castaneda, H., & Cervone, S. (2005). Mountains and biocultural diversity. *Mountain Research and Development*, *25*, 223–227. https://doi.org/10.1659/0276-4741(2005)025[0223:MABD]2.0.CO;2

Sterling, E. J., Filardi, C., Toomey, A., Sigouin, A., Betley, E., Gazit, N., … Jupiter, S. D. (2017). Biocultural approaches to well-being and sustainability indicators across scales. *Nature Ecology & Evolution*, *1*, 1798–1806. https://doi.org/10.1038/s41559-017-0349-6

Sterling, E., Ticktin, T., Kipa Kepa Morgan, T., Cullman, G., Alvira, D., Andrade, P., … Wali, A. (2017). Culturally grounded indicators of resilience in social–ecological systems. *Environment and Society: Advances in Research*, *8*, 63–95. https://doi.org/10.3167/ares.2017.080104

Temudo, M. P., Figueira, R., & Abrantes, M. (2015). Landscapes of bio-cultural diversity: Shifting cultivation in Guinea-Bissau, West Africa. *Agroforestry Systems*, *89*, 175–191. https://doi.org/10.1007/s10457-014-9752-z

Thomas, M., & Caillon, S. (2016). Effects of farmer social status and plant biocultural value on seed circulation networks in Vanuatu. *Ecology and Society*, *21*. https://doi.org/10.5751/ES-08378-210213

Torres-salcido, G., Ramos-chávez, A., & Urreta-fernández, Á. (2016). Bio-cultural anchorage of the prickly pear cactus in Tlalnepantla (Morelos), Mexico. *Culture & History Digital Journal*, *5*, 1–14.

Turner, K. L., Davidson-Hunt, I. J., Desmarais, A. A., & Hudson, I. (2016). Creole hens and ranga-ranga: Campesino foodways and biocultural resource-based development in the Central Valley of Tarija, Bolivia. *Agriculture (Switzerland)*, *6*.

Turner, K. L., Davidson-Hunt, I. J., & Hudson, I. (2018). Wine, cheese and building a gourmet territory: Biocultural resource-based development strategies in Bolivia. *Canadian Journal of Development Studies*, *39*, 19–37. https://doi.org/10.1080/02255189.2017.1331158

Turner, N. J., Deur, D., & Mellott, C. R. (2011). 'Up on the mountain': ethnobotanical importance of montane sites in Pacific Coastal North America. *Journal of Ethnobiology*, *31*, 4–43. https://doi.org/10.2993/0278-0771-31.1.4

Turvey, S. T., & Pettorelli, N. (2014). Spatial congruence in language and species richness but not threat in the world's top linguistic hotspot. *Proceedings of the Royal Society B: Biological Sciences*, *281*. https://doi.org/10.1098/rspb.2014.1644

van Dijk, H., Vincent, M., Casas, A., & Moreno-Calles, A. I. (2017). Semiarid ethnoagroforestry management: Tajos in the Sierra Gorda, Guanajuato, Mexico. *Journal of Ethnobiology and Ethnomedicine*, *13*, 1–11.

Vierikko, K., Elands, B., Niemelä, J., Andersson, E., Buijs, A., Fischer, L. K., … Konijnendijk van den Bosch, C. (2016). Considering the ways biocultural diversity helps enforce the urban green infrastructure in times of urban transformation. *Current Opinion in Environmental Sustainability*, *22*, 7–12. https://doi.org/10.1016/j.cosust.2017.02.006

Wergin, C. H. (2016). Collaborations of biocultural hope: Community science against industrialisation in Northwest Australia. *Ethnos*, *1844*, 1–17.

West, S., Haider, L. J., Masterson, V., Enqvist, J. P., Svedin, U., & Tengö, M. (2018). Stewardship, care and relational values. *Current Opinion in Environmental Sustainability*, *35*, 30–38. https://doi.org/10.1016/j.cosust.2018.10.008

Wiersum, K. F. (2017). New interest in wild forest products in Europe as an expression of biocultural dynamics. *Human Ecology*, *45*, 787–794. https://doi.org/10.1007/s10745-017-9949-7

Winter, K., Beamer, K., Vaughan, M., Friedlander, A., Kido, M., Whitehead, A., … Nyberg, B. (2018). The Moku system: Managing biocultural resources for abundance within social–ecological regions in Hawai'i. *Sustainability*, *10*, 3554. https://doi.org/10.3390/su10103554

Winter, K., Lincoln, N., & Berkes, F. (2018). The social–ecological keystone concept: A quantifiable metaphor for understanding the structure, function, and resilience of a biocultural system. *Sustainability*, *10*, 3294.

Wolverton, S., Nolan, J. M., & Ahmed, W. (2014). Ethnobiology, political ecology, and conservation. *Journal of Ethnobiology*, *34*, 125–152. https://doi.org/10.2993/0278-0771-34.2.125

Zapico, F. L., Aguilar, C. H., Abistano, A., Turner, J. C., & Reyes, L. J. (2015). Biocultural diversity of Sarangani Province, Philippines: An ethno-ecological analysis. *Rice Science*, *22*, 138–146. https://doi.org/10.1016/j.rsci.2015.05.018

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Hanspach J, Jamila Haider L, Oteros-Rozas E, et al. Biocultural approaches to sustainability: A systematic review of the scientific literature. *People Nat*. 2020;2:643–659. https://doi.org/10.1002/pan3.10120